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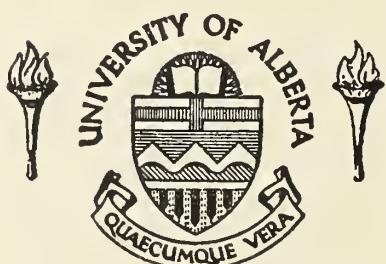
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THE UNIVERSITY OF ALBERTA

PERMIAN FAUNA  
FROM THE YUKON TERRITORY

A THESIS  
SUBMITTED TO THE FACULTY OF GRADUATE STUDIES  
IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE  
OF MASTER OF SCIENCE

DEPARTMENT OF GEOLOGY

by

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September, 1962



UNIVERSITY OF ALBERTA  
FACULTY OF GRADUATE STUDIES

The undersigned certify that they have read and recommend  
to the Faculty of Graduate Studies for acceptance a thesis entitled,  
"Permian Fauna from the Yukon Territory," submitted by Bruce Edwin  
Balfour Cameron in partial fulfilment of the requirements of the degree  
of Master of Science:

Sept. 5, 1962



## ABSTRACT

Twenty-three brachiopods, one gastropod, seven smaller foraminifera and fourteen ostracods are described and illustrated from the Permian portion of the Tika Creek section in southeastern Yukon Territory. Of these, three brachiopod and six ostracod species are recognized as new. A fusulinid species from the Tatonduk River in west-central Yukon Territory is also described. Stratigraphic ranges of species common to the Tika Creek and Tatonduk River sections are noted.

Brachiopods and fusulinids are used as a basis for correlation with the Canadian Arctic Archipelago, Alaska, Greenland, Spitzbergen, the Russian standard section, central Oregon and Texas.

The brachiopod species indicate an Upper Leonardian (Upper Artinskian) to Lower Guadalupian (Lower Kungarian) age; the fusulinid, however, suggests the older age is the more probable.

The disconformity placed between the Assistance and Belcher Channel Formations on Grinnell Peninsula (Harker and Thorsteinsson, 1960) is considered to be of small magnitude.



#### ACKNOWLEDGMENTS

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Shell Oil of Canada Limited kindly allowed the writer to describe the fossils collected by them in the summer of 1961, from the Tika Creek section. Dr. S. J. Nelson made the collections from the Tatonduk River available to the writer and allowed the writer to include a description of the fusulinid fauna in the present work.

Frank Dimitrov greatly assisted the writer in the photography and preparation of plates.



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## INTRODUCTION

Until 1960, very little work had been done on the Permian deposits of Arctic Canada. In that year Harker and Thorsteinsson described the succession and fauna on Grinnell Peninsula. This was the first extensive study of the Permian in the Canadian Arctic and forms an excellent basis for future work. The present study discusses the Arctic Permian fauna of the Yukon Territory and its position in the standard succession. The fauna under study consists of foraminifera, ostracods, and megafossils from two sections.

The sections are located (see figure 1) on Tika Creek and Tatonduk River, Yukon Territory. The Permian on Tika Creek is confined to about the upper 400 feet above the Mattson Formation. The section is located in southeastern Yukon (Lat. $60^{\circ}$ , 44'N; Long. $125^{\circ}$ , 52'W.). The Tatonduk River section is located on Tatonduk River in west-central Yukon (Lat. $65^{\circ}$ , 12'N; Long. $140^{\circ}$ , 39;W.). The Tika Creek section was measured and described by Shell Oil Company geologists in 1961, while the Tatonduk River section was described under the supervision of Dr. S. J. Nelson in 1959.

### General Section Description

The Mattson Formation was erected by Patton (1958) for 3,734 feet of sandstones, shales, and siltstones exposed on the South Nahanni River approximately 75 miles northeast of Tika Creek. The age Patton assigned to the formation was Meramecian and Chesterian possibly with some Pennsylvanian. The Permian portion of the Tika Creek section is, therefore, younger than type-section Mattson.



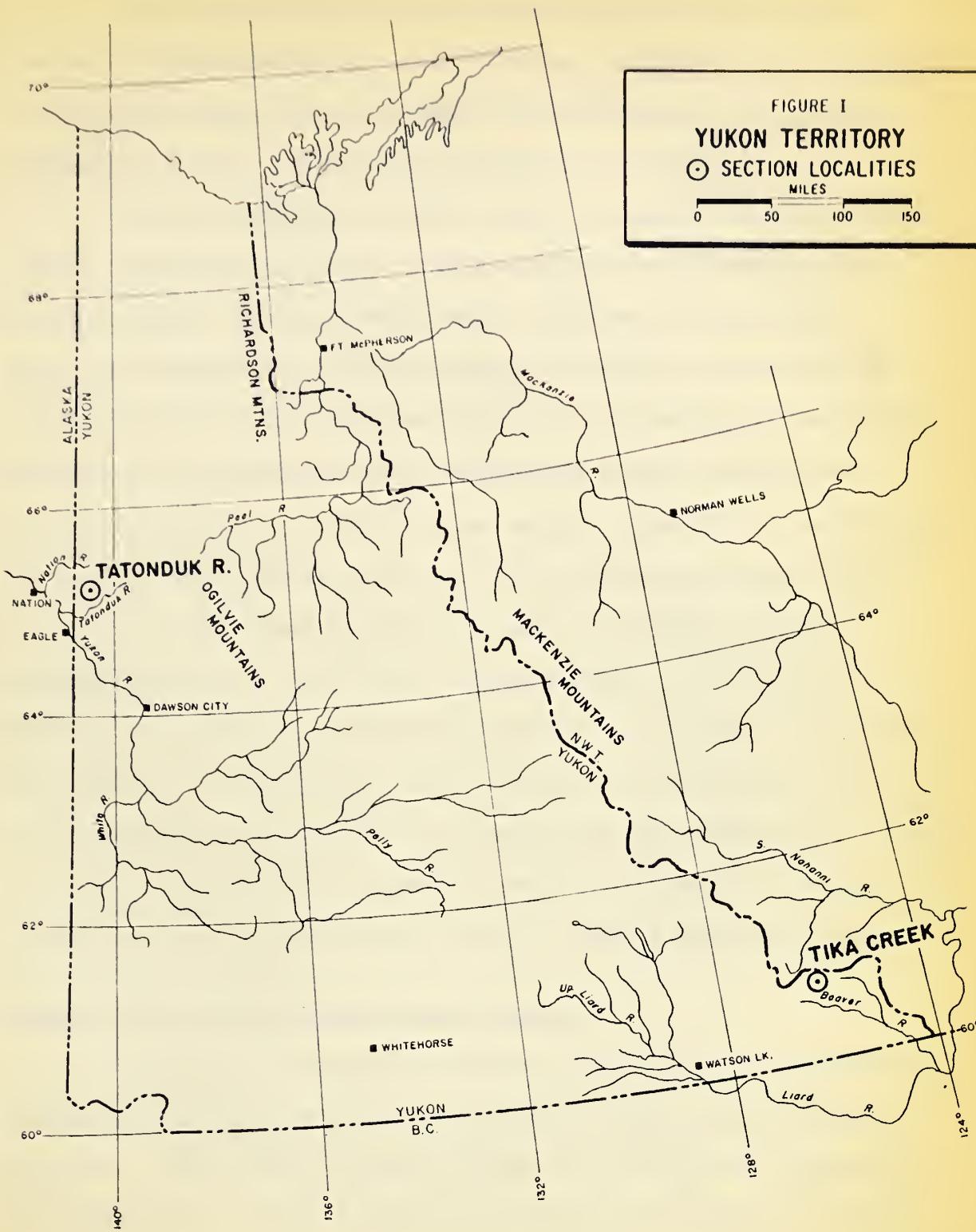


Figure 1. Section Locality map.



The upper portion of the Mattson Formation on Tika Creek consists of approximately 400 feet of shales, limestones, and sandstones, and some chert lenses (near the top of the section) and is apparently conformable with the (?) Pennsylvanian part of the Mattson.

The Tatonduk River section consists of 4770 feet of sandstones, cherts, limestones, and shales ranging in age from Mississippian to Permian (Nelson, 1961; and pers. comm.). The lower "Calico Bluff equivalent" consists of 1570 feet mainly of limestones and shales and is considered to be Mississippian in age. It is overlain by the "Lower Limestone Unit" of possible Pennsylvanian age (Nelson, 1962), which consists of 900 feet of limestones and shales. This unit is succeeded by the poorly exposed "Middle Recessive Unit" which is approximately 800 feet of shales and limestones and considered to be Lower Permian, Wolfcampian, in age. The "Middle Recessive Unit" is overlain by the Upper Limestone Unit ("Tahkandit Limestone equivalent") of Leonardian and possibly early Guadalupian age. This unit is approximately 1500 feet thick and consists of limestones and shales, grading upwards into siltstones and coarser clastics in the upper 650 feet (see figure 2). The tops of the Permian sections on Tatonduk River and Tika Creek sections were covered.

#### History of the North American Arctic Permian

The first collections of Permian fossils from the Canadian Arctic Archipelago were made by Sir Edward Belcher in 1852, and were largely coralline. These were described by Salter in 1855 and were assigned to the Carboniferous. These collections, made in the vicinity of Grinnell Peninsula, were recently incorporated in a report by Harker and Thorsteinsson (1960).



The Alaskan faunas are essentially the same as those in the Yukon and on Grinnell Peninsula. They have been listed and briefly mentioned by Girty, Williams, Mertie, and Moffit, although they have never been described. Identification of the fauna was undertaken by Girty (see Mertie, 1930), who concluded they were Lower Permian in age.

The first extensive work on the North American Arctic Permian was carried out in 1955 by the Geological Survey of Canada during "Operation Franklin" in which the section on Grinnell Peninsula was measured. Elements of the Arctic Permian fauna extends south in the Rocky Mountains at least as far as Central Oregon (Cooper, 1957).

#### The Arctic Permian Fauna

The Arctic Permian fauna, as defined by Harker (1960, p.15) is characterized by the following genera: Derbyia, Streptorhynchus, Dictyoclostus, Muirwoodia, Kochipructus, Waagenoconcha, Stenoscisma, Rhynchopora, Pterospirifer, and Spiriferella. In some areas horridonid brachiopods are important, as well as species of Choristites and Liosotella. The fauna is very widespread in Arctic regions, occurring in the Arctic Archipelago, Yukon Territory, Alaska, Greenland, Bear Island, Spitzbergen, Novaya Zemla, and elements of it in North America have been reported as far south as Oregon.

#### Purpose of Project

The microfauna and megafauna of the upper part of the Mattson



Formation on Tika Creek were described in order to evaluate their stratigraphic significance in regional correlations. The fauna collected from 250 to 320 feet below the top of the measured section was composed of twenty-five brachiopod species, two gastropods, fourteen ostracods, and seven smaller foraminifera. Stratigraphic occurrences of the same brachiopod species on the Tatonduk River section were recorded to aid in the correlation.

Fairly early in the investigation, it was realized that the smaller foraminifera would be of little use due to their poor preservation. As a result, part of the collections from Tatonduk River was incorporated in the study, notably the fusulinid species. This fusulinid species provided an age for the base of the Upper Limestone Unit on Tatonduk River, and assisted in the correlation with Grinnell Peninsula and the Russian standard section.



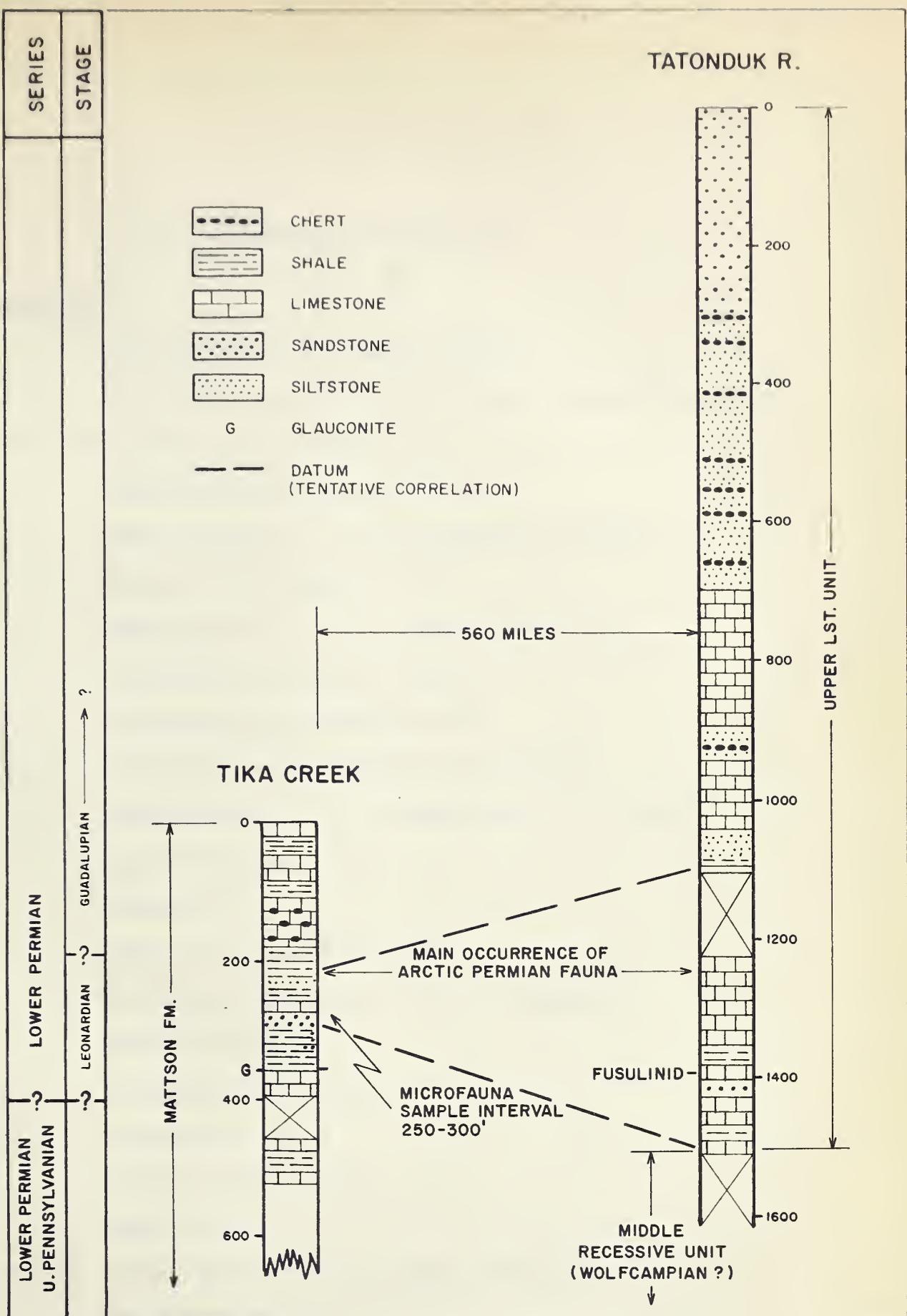


Figure 2.

Generalized lithology and correlation of Tika Creek and Tatonduk River sections.



## STRATIGRAPHY AND PALEONTOLOGY

### Megafauna

#### Upper portion of the Mattson Formation

The megafauna collected from the Upper Mattson Formation on Tika Creek includes the following species:

Dictyoclostus neoinfatus (Licharew)

Dictyoclostus sp., cf. D. boliviensis (d'Orbigny)

Muirwoodia greenlandica Dunbar

Waagenoconcha sp., cf. W. irginae (Stuckenberge)

Kochipructus freboldi (Stepanov)

Echinoconchus inexpectatus Cooper

Cancrinella cancriniformis (Tschernyschew)

Linopructus sp., cf. L. tenuistriatus (de Verneuil)

Spinomarginifera n. sp.

Chonetina sp. A

Squamularia rostrata (Kutorga)

Spiriferella keilhavii (von Buch), sensu lato

Martinia sp. A

Choristites soderberghi Dunbar

Choristites n. sp. A

Spirifer osborni Harker

Neospirifer sp. A

Pterospirifer sp., cf. P. alatus (Schlotheim)

?Spiriferina sp. A

Streptorhynchus kempei Anderson



Streptorhynchus sp. cf. S. stoschensis Dunbar

Stenoscisma n. sp.

Orbiculoides sp. A

Cyclioscapha sp. A

Dielasma sp.

Lingula sp.

bellerphontid gastropod

The last three are fragmentary.

Of the twenty-five species of productid brachiopods, species of Dictyoclostus, Linoprotuctus, and Kochiprotuctus, are predominant. Squamularia rostrata, Martinia sp. A, Choristites soderberghi, and Pterospirifer sp. cf. P. alatus are the most common spiriferids. In general, only two or three specimens of the remaining species were collected, thus adequate sectioning was not possible. Most shells were distorted and broken but were, in general, identifiable.

The assemblage from Tika Creek is remarkably similar to that from the Assistance Formation on Grinnell Peninsula. Notable absences from both localities were horridonid brachiopods.

#### Upper Limestone Unit

Brachiopod species common to the Upper Limestone Unit on Tatonduk River and the upper portion of the Mattson Formation on Tika Creek are:

Dictyoclostus neoinflatus (Licharew)

Dictyoclostus sp. cf. D. boliviensis (d'Orbigny)

Muirwoodia greenlandica Dunbar



Waagenoconcha sp. cf. W. virginiae (Stuckenbergs)

Kochinproductus treboldi (Stepanov)

Echinoconchus inexpectatus Cooper

Spiriferella keilhavii (von Buch), sensu lato

Martinia sp. A

Choristites soderberghii Dunbar

Linoproductus sp. cf. L. tenuistriatus (de Verneuil)

Although some of these species occur below the Upper Limestone Unit, the fauna was concentrated near the base, slightly higher stratigraphically than the fusulinid species. This assemblage is an important part of the Arctic Permian fauna and can be readily correlated to Grinnell Peninsula and Tika Creek (see figure 2).

#### Microfauna

A varied but poorly preserved assemblage of smaller foraminifera and ostracods was collected from the silty shales of the upper part of the Mattson Formation in the interval 250 to 320 feet below the top of the measured section. Their distribution is shown in figure 3. Specimen abundance was low, becoming moderate in the interval 280 to 300 feet below the top. For this reason, no microfossil zonation was attempted.

#### Smaller Foraminifera

Included among the foraminifera are:

Ammodiscus sp. A

Ammobaculites sp. A

Haplophragmoides sp. A

?Palaeotextularia sp. A

?Palaeotextularia sp. B



SPECIES	250'	VR	R	VR	A	R	VR	-	
INTERVAL DISTANCE IN FEET FROM TOP OF SECTION	260'	VR	R	VR	A	-	C	-	
GARNET	-	-	-	-	-	-	-	-	
HORNBLENDE	-	-	-	-	-	-	-	-	
FROSTED CHERT	-	-	-	-	-	-	-	-	
FROSTED QUARTZ	-	-	-	-	-	-	-	-	
GLAUCONITE	-	-	-	-	-	-	-	-	
BOTRYOIDAL PYRITE	-	-	-	-	-	-	-	-	
EUHEDRAL PYRITE	-	-	-	-	-	-	-	-	
GRAPHIADACTYLIS SP.	-	-	-	-	-	-	-	-	
CAVELLINA SP. CF. C. FITTSI	-	-	-	-	-	-	-	-	
CAVELLINA ELLIPTICALIS	-	-	-	-	-	-	-	-	
PSEUDOBYTHOCYPRIS PEDIFORMIS	-	-	-	-	-	-	-	-	
SEMINOLITES SP.	-	-	-	-	-	-	-	-	
HEALDIOIDES SP.	-	-	-	-	-	-	-	-	
WAYLANDELLA SP. B.	-	-	-	-	-	-	-	-	
WAYLANDELLA SP. A.	-	-	-	-	-	-	-	-	
HEALDIA SP. A.	-	-	-	-	-	-	-	-	
HEALDIA SUBANGULARIS	-	-	-	-	-	-	-	-	
PSEUDOPARAPARCHITES SP.	-	-	-	-	-	-	-	-	
BAIRDIA SP. CF. B. HURWITZI	-	-	-	-	-	-	-	-	
BAIRDIA SP. CF. B. MATFIELDENSIS	-	-	-	-	-	-	-	-	
GLYPTOPLEUROIDES SP.	-	-	-	-	-	-	-	-	
NODOSINELLA SP.	-	-	-	-	-	-	-	-	
PALAEOTEXTULARIA ? SP. B.	-	-	-	-	-	-	-	-	
PALAEOTEXTULARIA ? SP. A.	-	-	-	-	-	-	-	-	
SPIROPLECTAMMINA SP.	-	-	-	-	-	-	-	-	
AMMOBACULITES SP.	-	-	-	-	-	-	-	-	
HAPLOPHRAGMOIDES SP.	-	-	-	-	-	-	-	-	
AMMODISCUS SP.	-	-	-	-	-	-	-	-	

VA = > 40 SPECIMENS, VERY ABUNDANT  
 C = 10-20 SPECIMENS, COMMON  
 R = 5-10 SPECIMENS, VERY RARE

Figure 3. Stratigraphic distribution and frequency chart of foraminalifa, ostracoda and minerals from the Permian of Tika Creek.



Spiroplectammina sp. A

Nodosinella sp. A

All specimens were silicified and in many cases pyritized so that specific assignment was difficult. The species of Haplophragmoides and Spiroplectammina, however, appear to be new. In others, even the generic assignment is questionable since the wall structure could not be ascertained.

The species of Nodosinella and Spiroplectammina were the only useful ones for dating the assemblage. The age assigned using the smaller foraminifera is questionably Upper Pennsylvanian to Lower Permian.

Cummings (1955) restricted Nodosinella to the Permian and Pennsylvanian, with the type species, N. digitata Brady, from the Lower Permian of Britain. The other useful species is Spiroplectammina which, due to its rather unique arrangement of chambers, suggests an Upper Pennsylvanian to Lower Permian age. The only comparable species was described from the Upper Pennsylvanian and Lower Permian of Texas.

A more precise age using the smaller foraminifera could not be ascertained since the preservation of the specimens did not allow the wall structure to be investigated. The genus Nodosinella was recognized by its infolded wall forming the septa.

Ostracods

The ostracod fauna is composed of the following:

Glyptopleuroides sp. A

Pseudoparaparchites sp. A

Bairdia sp. cf. B. matfieldensis Upson



Bairdia sp. cf. B. hurwitzi Coryell and Booth

Healdia subangularis Delo

Healdia sp. A

Waylandella sp. A

Waylandella sp. B

Healdioides sp. A

Seminolites sp. A

Pseudobythocyparis pediformis (Knight)

Cavellina ellipticalis Hamilton

Cavellina sp. cf. C. fittsi Kellett

Graphiadactylis sp. A

The assemblage indicates a Middle Pennsylvanian to Lower Permian age. Only two of the specifically identified ostracods have been described from the Permian. These are Bairdia matfieldensis, and Cavellina ellipticalis; the former from the Wolfcampian of Nebraska, the latter from the basal Guadalupian of Texas. Pseudobythocyparis pediformis ranges from the Middle Pennsylvanian to Permian of Kansas and Missouri, while all other formally named species were originally described from the Pennsylvanian.

In view of their occurrences in the Permian portion of the Mattson Formation, the stratigraphic ranges of the following genera must be extended beyond those given by Benson et al. (1961):

Glyptoleuroides (from Upper Mississippian)

Pseudoparaparchites (from Mississippian and Pennsylvanian)

Healdioides (from Upper Mississippian)



Seminolites (from Pennsylvanian)

Graphidactyllis (from Mississippian)

The fauna appears to be a relict assemblage, having suffered only specific changes since the Pennsylvanian.

None of the distinctly Permian genera such as: Haworthina, Suchonella, Suchonellina, Tomiella, and Whipplella, were encountered in the fauna.

The independent age determined by ostracods cannot be more closely specified than Pennsylvanian to Permian. Further examination of similar sections must be carried out before this ostracod fauna can be evaluated for stratigraphic purposes.

#### Fusulinid Fauna from the Upper Limestone Unit

A very abundant fusulinid fauna was located at the base of the Upper Limestone Unit on the Tatonduk River section. Although specimens were abundant, only one species Schwagerina hyperborea (Salter) was encountered occurring at 1400 feet below the top of the section. Specimens constituted up to 50% of the rock in places and preservations were very good. A large percentage of the specimens however, were crushed or broken.

#### Age assignment by Schwagerina hyperborea

This species is not known outside the Canadian Arctic although it occurs in two widely separated areas, having been reported previously from Grinnell Peninsula. The published stratigraphic range of Schwagerina



is Lower Wolfcampian to Upper Guadalupian, (the Yabeina zone of British Columbia (Thompson and Wheeler, 1942)). Schwagerina hyperborea is an advanced species of Schwagerina indicating a Leonardian age. Parafusulina durhami from the Glass Mountains of Texas is a very closely related species (see description of S. hyperborea) and occurs within 100 feet of the top of the Leonard Formation of the Glass Mountains. It is reasonable to suggest an Upper Leonardian age therefore, for the base of the Upper Limestone Unit on Tatonduk River.



## Correlation

### Yukon Territory

A list of the species common to both the upper part of the Mattson Formation on Tika Creek and the Upper Limestone Unit on Tatonduk River has already been given (see page 8). As stated, the main elements of the Arctic Permian fauna occur at about 1270 feet below the top of the Tatonduk River section, 150 feet higher than the fusulinid species. The fauna as a whole ranged from 100 feet below the top to the base of the Upper Limestone Unit. Cancrinella cancriniformis, Squamularia rostrata, Linoproductus sp. cf. L. tenuistriatus, Muirwoodia sp. cf. M. greenlandica, and Martinia sp. were also found in the Lower Limestone Unit of (?) Pennsylvanian age. Horridonid brachiopods were common in both the Upper Limestone Unit and Lower Limestone Unit (Nelson, 1962), but were absent in the Tika Creek section.

The stratigraphic relationship of the main occurrence of the Arctic Permian fauna suggests the most suitable correlation is between the interval 243 to 300 feet on the Tika Creek section and approximately 1270 feet below the top of the Tatonduk River section (see figure 2).

### Grinnell Peninsula

The Assistance Formation on Grinnell Peninsula consists of about 200 feet of mainly unconsolidated glauconitic clastic sediments. It is underlain by the Belcher Channel Formation and presumably separated from it by a disconformity (Harker, 1960, p.9). The Arctic Permian fauna occurs in the Assistance Formation and has the following species in common with



the upper portion of the Mattson Formation on Tika Creek:

Dictyoelostus neoinflatus (Licharew)

Dictyoelostus sp. cf. D. boliviensis (d'Orbigny)

Waagenoconcha sp. (similar species to both localities)

Spiriferella keilhavii (von Buch), sensu lato

Spirifer osborni Harker

Pterospirifer sp. cf. P. alatus (Schlotheim)

Kochiproductus freboldi (Stepanov)

Streptorhynchus kempeii Andersson

Orbiculoides sp. A

Dielasma sp.

Lingula sp.

The two assemblages are undoubtedly the same and are probably contemporaneous..

The Belcher Channel Formation varies in thickness from 650 to 820 feet and consists of coarse clastic sediments at the base, grading up into limestones and quartzose limestones. Fusulinid species occur throughout the formation indicating an age from Wolfcampian to Leonardian. Schwagerina hyperborea occurs near the top of the Belcher Channel Formation, thus suggesting an Upper Leonardian age. A correlation between the upper part of the Belcher Channel Formation on Grinnell Peninsula and the base of the Upper Limestone Unit on Tatonduk River is, therefore, most likely. This correlation is further strengthened by the occurrence of the Arctic Permian fauna in both localities stratigraphically slightly higher than the fusulinid species.



Assuming the above correlation, the age of the Arctic Permian Fauna must be Upper Leonardian to possibly Lower Guadalupian (Word Formation of Texas).

Harker and Thorsteinsson (1960) placed a disconformity between the Belcher Channel Formation and the Assistance Formation on Grinnell Peninsula. Since the Arctic Permian fauna in the Upper Limestone Unit on Tatonduk River occurs associated with, or slightly above Schwagerina hyperborea, it would seem that the disconformity on Grinnell Peninsula if present at all, is of a minor nature.

#### Alaska

The type locality of the Tahkandit Limestone of Lower Permian age is on the Yukon River just above the mouth of the Nation River (see figure 1). It is underlain by the Nation River Formation of (?) Pennsylvanian age and overlain and possibly faulted against Upper Triassic. At the type locality 527 feet of strata are exposed, with limestones in the upper part and clastics in the lower. The limestones are richly fossiliferous with 123 species reported (Girty, in Mertie, 1930). This large assemblage has never been formally described but the faunal lists suggest it belongs to the Arctic Permian fauna.

The Arctic Permian fauna has also been reported from the DeLong Mountains in Northern Alaska (Tailleur *et al.*, 1958). Dutro (1961) placed this fauna in the Kazanian stage of the Permian mainly on the basis of the genus Licharewia, an index genus for Upper Permian of the U.S.S.R. Dutro believes this genus occurs on Grinnell Peninsula. The present study shows, however, the age of the Arctic Permian fauna is Leonardian (Artinskian)



to possibly Lower Guadalupian (Kungarian) based on fusulinid species.

#### Greenland

The faunas of east-central Greenland (Dunbar, 1955) have many similarities with the Arctic Permian fauna of Northern Canada, and appear contemporaneous. The Arctic Permian fauna occurs in the Brachiopodenkalk, Productus Limestone and Posidonia Schiefer of east-central Greenland, which may to some degree be facies equivalents. Dunbar correlated the east-central Greenland fauna with the Zechstein of Germany and the Magnesian Limestone of England, thus assigning a Kazanian age. This correlation was based upon a few brachiopod species such as: Pterospirifer alatus (Schlotheim), Spiriferina multiplicata King and Dielasma elongatum Schlotheim.

The close similarities between the faunas of Greenland and the Canadian Arctic suggests the former may be more properly dated as Upper Leonardian to Lower Guadalupian.

#### Russian type section

Ross (1962), in a study of the fusulinid fauna of the Leonard Formation of Texas, concluded that the Leonard Formation may be correlative with the upper part of the Sakmarian Series, although most of it was equivalent to the Artinskian. Parafusulina durhami from the Upper Leonard Formation of Texas, P. tschussovensis from the Upper Artinskian Series of the Southern Urals, and Schwagerina hyperborea from the basal part of the Upper Limestone Unit on Tatonduk River all represent approximately the same evolutionary stage of development. Schwagerina hyperborea, would therefore appear to be Upper Artinskian (=Upper Leonardian) in age.



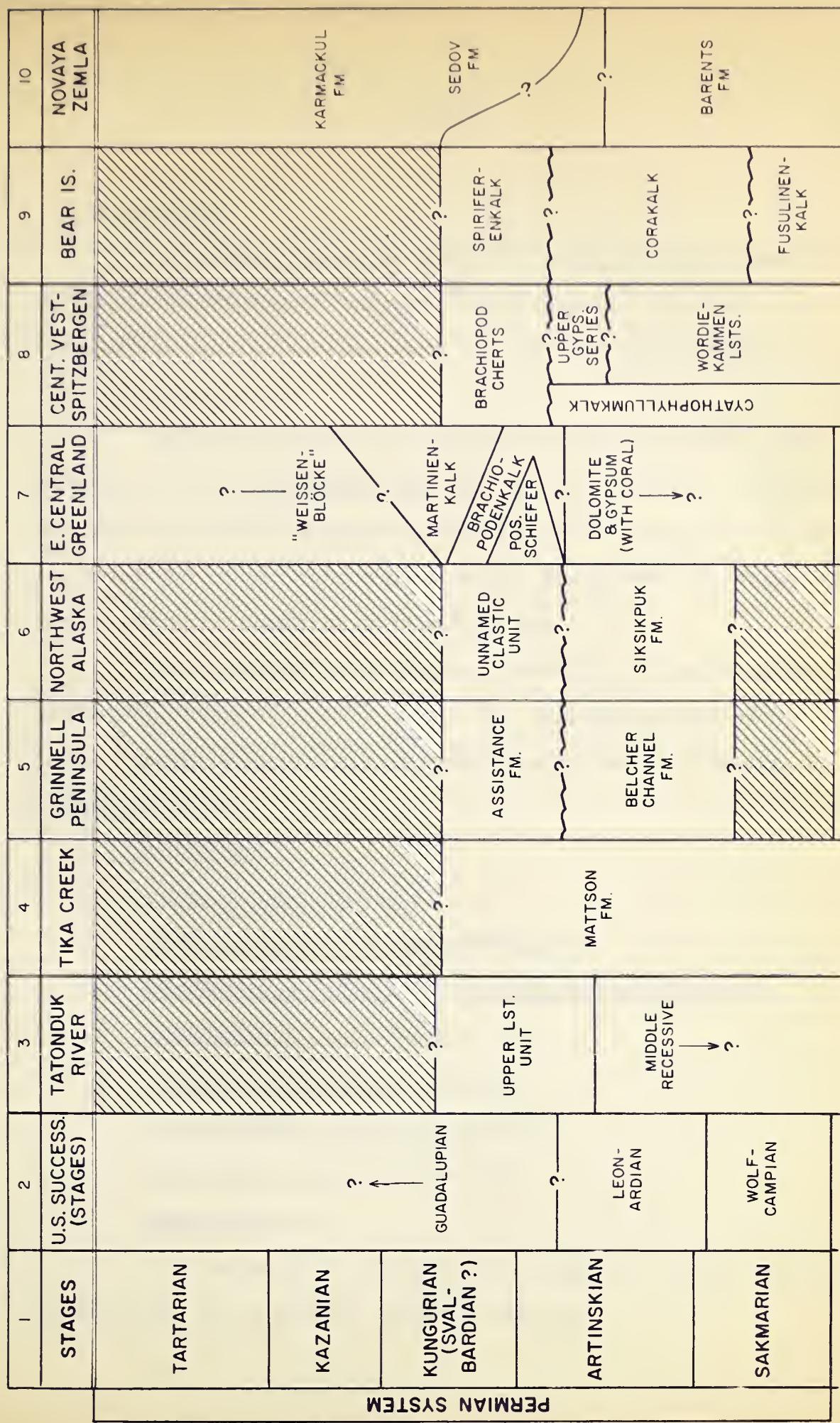


Figure 4 Correlation Chart

modified after:  
 Column 3, Nelson (1961); Column 6, Dutro (1962);  
 Columns 5, 7, 9, 10 Harker (1960); Column 8, Forbes et al (1958).



### Spitzbergen

The Permian succession in central Vestspitsbergen consists of the Upper Wordiekammen Limestones disconformably overlain by the Upper Gypsiferous Series which is in turn overlain disconformably by the Brachiopod Cherts.

The Upper Wordiekammen Limestones contain fusulinid species assignable to the Pseudoschwagerina Zone and thus indicate a Sakmarian age. The fauna of the Upper Gypsiferous Series is sparse and seems from the few productids present to be related to the Wordiekammen Limestones and so is probably of Sakmarian or Artinskian age.

The Brachiopod Cherts appear to overlie the Upper Gypsiferous Series disconformably (Forbes, 1960). The following species of the Arctic Permian fauna have been recorded from the Lower and Middle Brachiopod Cherts:

Stenoscisma sp.

Dielasma plica (Kutorga)

Dictyoclostus boliviensis (d'Orbigny)

Dictyoclostus inflatus (? = D. neoinflatus (Licharew))

Waagenoconcha payeri (Toula)

Streptorhynchus kempei Andersson

Streptorhynchus triangularis Wiman

Spiriferella keilhavii (von Buch)

Neospirifer sp.

This assemblage is obviously very closely related to the Arctic Permian fauna and is probably about the same age.



Stepanov (1957) erected the Svalbardian Stage as the marine equivalent of the Kungurian on Spitzbergen. He considered the Spiriferenkalk (equivalent of the Brachiopod Cherts) of Spitzbergen and Bear Island to have a faunal complex of Kungurian age. The species most characteristic of the Svalbardian are: Horridonia borealis, Muirwoodia sp., Kutorginella? arctica (? = Dictyoclostus inflatus, Kozlowski), Spiriferella keilhavii, and S. polaris. The close similarity between the fauna of the Brachiopod Cherts (Spiriferenkalk equivalent) and the Arctic Permian fauna would indicate that the age of the Spiriferenkalk is Upper Artinskian and possibly the Lower Kungurian. It appears, therefore, that the Spiriferenkalk may be in part only the marine equivalent of the Kungurian.

The faunas of the Spiriferenkalk of Spitzbergen are very closely related to those of Bear Island and Novaya Zemla (Licharew and Einor, 1939).

#### Continental United States

Fusulinids indicate an Upper Leonardian correlation for the Arctic Permian fauna whereas brachiopods suggest correlation with both the basal Guadalupian (Word Formation) and Leonardian of the West Texas succession. Correlation between the Arctic Permian fauna and Texas fauna is difficult due to the lack of species common to both assemblages. The following is a partial list of Texas species comparable to those in the Arctic Permian fauna, proposed by King (1930) and supplemented by the present writer:



Texas

Arctic

Dictyoelostus arcticus Whitfield (= D. neoinflatus (Licharew)

Muirwoodia guadalupensis (Girty) (= M. mammatus Keyserling)

Dictyoelostus schucherti King (= D. boliviensis (d'Orbigny)

Cancrinella phosphaticus (Girty) (= C. cancriniformis Tschern.)

Derbyia nasuta Girty (= D. grandis Waagen)

Waagenoconcha montpelierensis Girty (= W. virginiae (Stuckenber)

Squamularia guadalupensis (Schumard) (= S. rostrata (Kutorga))

In the above list, the first two species are known from the basal Guadalupian, the third from the Leonard Formation, and the remainder from both the Leonardian and Guadalupian.

Cooper (1957) described a brachiopod fauna with Arctic affinities from central Oregon which he correlated to the Lower Guadalupian of the American succession and to the Middle or Upper Artinskian of the Russian. The species Echinoconchus inexpectatus and Squamularia rostrata were identical to those in the Arctic Permian fauna of the Yukon. The present study suggests, however, that this fauna may be slightly higher in the Russian type section and perhaps somewhat lower in the West Texas succession.



## CONCLUSIONS

From a study of both macrofossils and microfossils of the Permian of the Yukon Territory, the following conclusions can be stated:

- 1) The most favorable age assignment for the Arctic Permian fauna is Upper Artinskian to Lower Kungurian. The United States equivalents are in the Upper Leonardian to Lower Guadalupian. This is based upon:
  - a) Schwagerina hyperborea (Salter) indicating an Upper Leonardian age, and
  - b) the brachiopod assemblage of the Arctic Permian fauna having their greatest concentration in rocks of this age in both the Russian and West Texas successions.
- 2) The fauna in the upper part of the Mattson Formation on Tika Creek has not been reported from the type Mattson on the South Nahanni River. The Tika Creek Permian is, therefore, either stratigraphically higher than the upper part of the type Mattson, or correlative with it.
- 3) Smaller foraminifera and ostracods were of little use stratigraphically because of poor preservation, and the limited amount of study with them. The ostracods appear to represent a relict Pennsylvanian fauna.



## SYSTEMATIC DESCRIPTIONS

### Introduction

Twenty-three brachiopod species, one gastropod, fourteen ostracods, and seven smaller foraminifera are described from the Tika Creek section. The fossils were collected from the interval 243 to 310 feet below the top of the measured section. All figured microfossil and Tatonduk River megafossil material have been placed in the type collections of the University of Alberta, Department of Geology.

### Technique employed for microfossil recovery

Microsamples were collected from the interval 250 to 340 feet below the top of the measured section on Tika Creek. The samples were too consolidated for disintegration in water or by any other simple means. They were placed in a rock crusher and then treated with a warm 15% solution of hydrogen peroxide. The residues were collected on a 150 mesh screen and placed in an ultrasonic vibrator for 5 minutes. The samples were then dried and picked. The stratigraphic distribution of the recovered species is shown in figure 3.

## FORAMINIFERA

### Introduction

The upper portion of the Mattson Formation on Tika Creek yielded seven species of smaller foraminifera, four arenaceous, and three presumed to have been granular compound. The preservation was poor; specimens being, in many cases, both silicified and pyritized. For this reason no formal specific



assignments could be made. Assuming the wall structure might have been ascertained, comparative known species are briefly discussed.

One fusulinid species, Schwagerina hyperborea was recovered from near the base of the Upper Limestone Unit on Tatonduk River. Comparative species are found in the Upper Leonardian of Texas and the Upper Artinskian of Russia.

The classification adopted is that proposed by Loeblich and Tappan (1961).

Phylum Protozoa  
Subphylum Sarkodina  
Class Reticularea  
Subclass Granuloreticulosa  
Order Foraminiferida  
Superfamily Ammodiscacea  
Family Ammodiscidae  
Subfamily Ammodiscinae

Genus Ammodiscus Terquem, 1862

Ammodiscus sp. A

Plate 1, figures 1 - 2

The test is medium in size, discoidal, planispiral, and consists of a very small proloculum followed by a long undivided second chamber making 5 to 6 coils. The first two whorls increase in diameter gradually while the remainder increase more rapidly until the last whorl is quite large and overlaps the previous one slightly. The spiral suture



is well defined in the outer whorls but obscure in the earlier and is very slightly depressed. The wall is very finely arenaceous, has abundant cement and a smooth finish. Some specimens have a large mica flake agglutinated over the proloculum and first two whorls. The aperture is oval and formed by the open end of the tube.

The dimensions of figured specimen U. of A. No. PR-115 are: maximum diameter, 0.35 mm.; minimum diameter, 0.33 mm.; and thickness, 0.07 mm.

Remarks.

Approximately one-third of the collected specimens were laterally compressed due to crushing and, therefore may be mistaken for Glomospira.

This species is similar to Ammodiscus erugatus Crespin described from the Permian of Australia but is slightly thinner, has a less depressed suture, and may have less cement.

Horizon and Locality.

This species is the most abundant and has the greatest vertical range of any species collected from the Upper Mattson Formation by the present writer. It occurs in the interval 250 to 310 feet below the top of the Tika Creek section.

Superfamily Lituolacea

Family Lituolidae

Subfamily Haplophragmoidinae

Genus Haplophragmoides Cushman, 1910

Haplophragmoides sp. A

Plate 1, figures 3, 4



The test is planispiral, small, slightly evolute, and has 9 to 10 chambers in the outer whorl. The periphery is rounded and a small umbilicus is developed. The chambers are inflated and subtriangular in outline. The sutures are fairly distinct, somewhat thickened, slightly depressed and straight. The wall is finely arenaceous, with sufficient cement to create a smooth finish. The aperture is a high arched opening at the base of the terminal face.

The dimensions of figured specimen U. of A. No. PR-116 are: maximum diameter, 0.21 mm.; minimum diameter, 0.19 mm.; and thickness, 0.08 mm.

Remarks.

This species is characterized by its very small size and large number of chambers in the outer whorl. Most specimens are pyritized and silicified.

Horizon and Locality.

This species is common from 280 to 300 feet below the top of the Tika Creek section.

Subfamily Lituolinae

Genus Ammobaculites Cushman, 1910

Ammobaculites sp. A

Plate 1, figure 5

The test is small, with the early part planispiral, closely coiled, and consisting of at least two whorls as seen in the slight umbilicus. Six chambers are visible in the last whorl. The later



portion of the test is uniserial consisting of 2 to 3 large chambers having an almost circular cross section. The greatest width is formed by the coiled portion. The sutures are obscured by silicification, but in the coiled portion appear flush, and slightly depressed in the uniserial part. The wall is finely arenaceous, with little cement, and has a rather roughened surface. The aperture is terminal, circular, and slightly depressed.

The dimensions of figured specimen U. of A. No. PR-117 are: length, 0.35 mm.; greatest width of uniserial portion, 0.10 mm.; and greatest diameter of coil, 0.13 mm.

Remarks.

The distinctive features of this species are its small size, tightly coiled planispiral portion, and much larger uniserial chambers.

Horizon and Locality.

This species occurs rarely from 280 to 310 feet below the top of the Tika Creek section.

Family Textulariidae

Subfamily Spiroplectammininae

Genus Spiroplectammina Cushman, 1927

Spiroplectammina sp. A

Plate 1, figures 6, 7

The test is small and consists of an early planispiral portion of about 5 inflated chambers and becomes biserial in the adult. The biserial portion is twisted 90 degrees from the usual



arrangement in the genus and consists of 2 to 4 pairs of chambers, the last two being very inflated. The test tapers sharply from the greatest width near the apertural end. The planispiral portion of the test occupies from one-third to one-half the test length. The sutures are distinct and slightly depressed. The wall is finely arenaceous with much cement, giving the test a fairly smooth finish. The aperture is a fairly high, wide, slightly depressed notch at the base of the last formed chamber.

The dimensions of figured specimen U. of A. No. PR-118 are: length, 0.52 mm.; width, 0.30 mm.; thickness, 0.28 mm.; and maximum diameter of coil, 0.26 mm.

Remarks.

The outstanding feature of this species is the twisted biserial portion of the test relative to the planispiral stage. The only other similar species encountered is Spiroplectammina suttonensis Cushman and Waters from the Upper Pennsylvanian and Lower Permian of Texas. The Tika Creek species differs from S. suttonensis in having a much larger planispiral stage, a rounded cross-section, and being somewhat longer.

Horizon and Locality.

This species is common in the Tika Creek section 280 to 300 feet below the top of the section.

Superfamily Endothyracea

Family Nodosinellidae

Subfamily Nodosinellinae



Nodosinella sp. A

Plate 1, figures 8, 9

The test is elongate, uniserial, and rectilinear or very slightly curved. It increases gradually in diameter reaching its greatest width very near the apertural end. The chambers are subrectangular, wider than high, but increase in height towards the apertural end. The last suture is in a broad constriction indicating some thickening of the wall occurs at the previous sutures. The wall is granular, probably compound, and has a smooth finish. The aperture is a simple round opening in the center of the slightly domed apertural face.

The dimensions of figured specimen U. of A. No. PR-119 are: length, 0.67 mm.; and maximum diameter, 0.13 mm.

Remarks.

The preservation is not adequate to comment on the presence or absence of an "inner fibrous" layer. Thin-sections, however, show the septa are formed by an infolding of the wall (figure 5), which is characteristic of the genus (Cummings, 1955).

Specimens of Nodosinella from the Tika Creek section are very consistent in their small size, and the constriction prior to the last chamber.

Horizon and Locality.

This species is common in the upper part of the Mattson Formation on Tika Creek and occurs 300 feet below the top of the measured section.

Cummings (1955) notes that the occurrence of Nodosinella is restricted to European areas. If the Tika Creek specimens are properly assigned to this genus, they may be the first reported from North America.



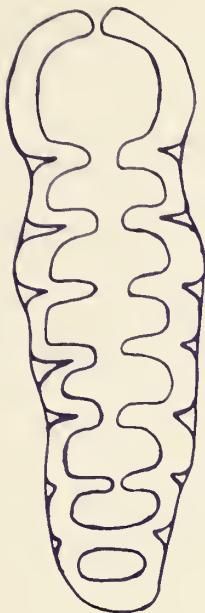


Figure 5. Section of Nodosinella  
sp. A, showing the formation of  
the septa by infolding of the wall.

X120

Family Palaeotextulariidae

Genus Palaeotextularia Schubert, 1920

?Palaeotextularia sp. A.

Plate 1, figures 10-11

The test is short, stout, rapidly tapering and consists of



6 to 8 pairs of chambers in a biserial arrangement. The greatest width is just below the apertural face. The chambers are wider than high, but subequal in the later portion of the test, and increase in size regularly. The sutures are distinct, oblique, and slightly depressed. The wall has been silicified but was probably granular compound since no indication of agglutinated material was seen. The aperture is a fairly high notch at the base of the last formed chamber.

The dimensions of the figured specimen, U. of A. No. PR-120 are: length, 0.59 mm.; width, 0.42 mm.; and thickness, 0.39 mm.

Remarks.

The distinguishing features of this species are its straight, inclined sutures and subrectangular apertural outline.

Horizon and Locality.

This species is very rare in the Upper Mattson Formation on Tika Creek, and occurs 300 feet below the top of the measured section.

?Palaeotextularia sp. B.

Plate 1, figures 12-13

The test is elongate, gently tapering, and consists of 6 to 7 pairs of inflated chambers arranged biserially. The greatest width is in the later one-third of the test length. The last three pairs of chambers are more inflated than the preceding ones. The sutures are fairly distinct, depressed and slightly oblique. The wall has been silicified but since no agglutinated material is apparent, the wall was probably granular compound. The test has a smooth finish. The aperture



is a fairly high, slightly broadened opening at the base of last formed chamber.

The dimensions of figured specimen, U. of A. No. PR-121 are: length, 0.69 mm.; width, 0.33 mm.; and thickness, 0.23 mm.

Remarks.

The Tika Creek species differs from Palaeotextularia angusta (Reitlinger) from the Carboniferous of Russia in being narrower, having a larger form ratio, and lacking the club-like extensions of the septa. Palaeotextularia consorbrina Lipina from the Lower Carboniferous of Russia is similar to the Tika Creek specimens in shape and size, but differs in having less inflated chambers.

Horizon and Locality.

This species is fairly abundant in the Tika Creek section in the interval 280 to 310 feet below the top.

Superfamily Fusulinacea

Family Fusulinidae

Subfamily Schwagerininae

Genus Schwagerina Möller, 1877

Schwagerina hyperborea (Salter), 1855

Plate 2, figures 1 - 7

Fusulina hyperborea Salter, 1855, p. 380, Plate 36, figs. 1-3

Schwagerina hyperborea (Salter). Thorsteinsson, 1960, p.26, Plate 6, figs. 1-6; Plate 7, figs. 1-3.

The test is large, highly elongate, and is subcylindrical becoming fusiform after the fourth volution. The length reaches up to



14 mm. and width up to 2.7 mm. in 7 volutions. The maximum form ratio at maturity is about 5.0.

The outside diameter of the proloculum varies from 0.18 mm. to 0.22 mm. and may be aspherical. The volutions increase in height quite uniformly and increase in height toward the bluntly rounded poles. The axis of coiling may be curved.

The wall increases in thickness rather uniformly until it attains a maximum of 0.10 mm. in the outer volution. The septa are strongly and regularly fluted, reaching the tops of the chambers or more commonly falling short forming rounded chamberlets. In some specimens, opposing folds meet, are very slightly reabsorbed and form weakly defined cuniculi which, if present at all, are confined to the outer volution.

The tunnel is narrow with the angle increasing from 13 degrees in the first volution to 38 in the fifth. Chromata are small and restricted to the inner 3 volutions. Secondary deposits are confined to the axial region within the first 4 volutions.

Measurements are given in Table 1.

Remarks.

Many sections of this species were cut with only a few showing very weakly developed cuniculi. For this reason, they are assigned to the genus Schwagerina and in particular to Schwagerina hyperborea as they are almost identical to specimens of this species collected from the upper part of the Belcher Channel Formation on Grinnell Peninsula.

Parafusulina durhami Thompson and Miller is similar to Schwagerina hyperborea in its evolutionary stage of development.



Schwagerina hyperborea differs in having even less well developed cuniculi, possessing chromata, and larger form ratios. Parafusulina durhami has been reported from 100 feet below the top of the Leonard Formation of the Glass Mountains of Texas.

Dunbar (1946) reported a species of Parafusulina from Alaska which had low cuniculi and probably represent about the same evolutionary stage of development as the Tika Creek species. Parafusulina alaskensis, although comparable in size and shape to S. hyperborea, lacks axial deposits and chromata.

Horizon and Locality.

Schwagerina hyperborea is very abundant in the Upper Limestone Unit on Tatonduk River, and occurs at 1400 feet below the top of the measured section.



TABLE I - Measurements of *Schwagerina hyperborea* (Salter)

Specimen	L	W	R	1/2 LENGTH							RADIUS VECTOR							TANDEM ANGLES											
				V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>					
PR-144	11.21*	2.30	4.66*	.177	.24	.51	.97	1.58	2.86	5.26	126	.190	2.72	4.21	7.85	.99	1.25	.87	2.58	1.54	1.75	1.4	2.2	4					
PR-145	14.05	2.34*	6.01	.216	.25	.67	.816	1.23	2.19	3.75	6.08	158	.193	2.69	3.61	5.48	750*	1.09*	.58	2.56	.54	3.22	4						
PR-146	2.43	-	.180	-	-	-	-	-	-	-	-	.146	.223	.328	.435	.660	.957	1.214	-	-	-	-	-	-					
PR-147	10.68	2.45	4.44	.160*	.256	.511	1.07	1.84	2.89	4.03	-	.112	.177	.288	.416	.75	1.03	-	2.30	2.48	1.72	4.42	1.44						
PR-148	-	2.36	-	.177	-	-	-	-	-	-	.170	.259	.408	.592	.86	1.20	-	-	-	-	-	-	-						
PR-149	9.54	1.89	5.05	.143	.177?	.416*	.652	8.16	1.84	4.79	.112	.193	.26	.598	.806	-	.56	2.15*	2.6	-	-	-	-	-					
PR-150	?	2.24	.128	.28	.657	1.135	2.178	3.30	4.64*	-	.162	.289	.49	.744	.91	-	.72	2.27	3	-	-	-	-	-					
PR-151	-	1.98	-	-	-	-	-	-	-	-	.151	.228	.323	.496	.724	.921	-	-	-	-	-	-	-						
PR-152	8.95	2.16	4.14	.177	.214	.56	.87	1.58	2.48	3.92	-	.114	.178	.30	.46	.681	1.01	-	.67	2.4	2.6	4.43	3.54	5.5					
PR-153	10.4*	2.31	4.5*	.216	.303	.543	1.14	1.79	3.11	5.21	-	.156	.215	.311	.46	.693	.944*	1.215	.54	2.52	2.7	4.43	5.5						
PR-154	-	2.34	-	.191	-	-	-	-	-	-	.143	.225	.344	.504	.824	1.215	-	-	-	-	-	-	-						
PR-155	11.6*	2.78	4.24	.200	.28	.76	1.38	2.58	3.30	4.19	6.08	.177	.257	.40	.568	.86	1.54	.29	1.54	.58	2.65	4.54	3.82	2					
THICKNESS SPIROTICHECA																													
Specimen	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	
PR-144	.012	.020	.028	.031	.050	.070	.073	-	-	-	-	-	-	-	.053	.093	.103	.121	.176	.289	.36	.46	.42	.42	.42	.42	.42	.42	
PR-145	.012	.018	.025	.046	.057	.072	.082	-	-	-	-	-	-	-	.048	.057	.0714	.122	.172	.227	.352*	.42	.42	.42	.42	.42	.42	.42	.42
PR-146	.012	.012	.023	.025	.04	.051	.095	.104	.18	.23	.25	.21	.34	.31	.030	.079	.087	.125	.211	.316	.42	-	-	-	-	-	-	-	-
PR-147	.015	.029	.023	.042	.053	.08	.104	-	-	-	-	-	-	-	.031	.08	.109	.136	.231	.303	-	.03	.03	.03	.03	.03	.03	.03	.03
PR-148	.016	.028	.038	.048	.067	.08	.14?	.19	.21	.28	.30	.30	.30	.30	.048	.085	.131	.177	.28	.39	-	-	-	-	-	-	-	-	-
PR-149	?	.028	.035	.048	.064	.074	-	-	-	-	-	-	-	-	.031	.048	.086	.114	.233	.275	-	.03	.03	.03	.03	.03	.03	.03	.03
PR-150	.031	.033	.046	.072	.087	-	-	-	-	-	-	-	-	-	.080?	.064	.111	.161	.25	.357	-	-	-	-	-	-	-	-	-
PR-151	.021	.031	.033	.056	.093	-	-	-	-	-	-	-	-	-	.028	.082	.107	.161	.225	.375	-	-	-	-	-	-	-	-	-
PR-152	.018	.029	.037	.042	.053	.089	-	-	-	-	-	-	-	-	.028	.057	.121	.176	.214	.330	-	.03	.03	.03	.03	.03	.03	.03	.03
PR-153	.014	.028	.033	.048	.063	.08	.143	-	-	-	-	-	-	-	.046	.059	.10	.151	.217	.302	.335?	.4	.20	.20	.20	.20	.20	.20	.20
PR-154	.014	.028	.036	.053	.077	-	12	18	21	26	27	34	-	-	.05	.095	.118	.171	.272	.351	-	-	-	-	-	-	-	-	-
PR-155	.015	.026	.031	.048	.071	.086	.112	-	-	-	-	-	-	-	.063	.097	.118	.168	.311	.368	.272	.16	.9	.23	.31	.31	.31	.31	.31
SEPTAL COUNT																													
Specimen	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	V <sub>1</sub>	V <sub>2</sub>	V <sub>3</sub>	V <sub>4</sub>	V <sub>5</sub>	V <sub>6</sub>	V <sub>7</sub>	
PR-144	.020	.028	.031	.050	.070	.073	-	-	-	-	-	-	-	-	.053	.093	.103	.121	.176	.289	.36	.46	.42	.42	.42	.42	.42	.42	.42
PR-145	.012	.018	.025	.046	.057	.072	.082	-	-	-	-	-	-	-	.048	.057	.0714	.122	.172	.227	.352?	.42	.42	.42	.42	.42	.42	.42	.42
PR-146	.012	.012	.023	.025	.04	.051	.095	.104	.18	.23	.25	.21	.34	.31	.030	.079	.087	.125	.211	.316	.42	-	-	-	-	-	-	-	-
PR-147	.015	.029	.023	.042	.053	.08	.104	-	-	-	-	-	-	-	.031	.08	.109	.136	.231	.303	-	.03	.03	.03	.03	.03	.03	.03	.03
PR-148	.016	.028	.038	.048	.067	.08	.14?	.19	.21	.28	.30	.30	.30	.30	.048	.085	.131	.177	.28	.39	-	-	-	-	-	-	-	-	-
PR-149	?	.031	.033	.046	.072	.087	-	-	-	-	-	-	-	-	.080?	.064	.111	.161	.25	.357	-	-	-	-	-	-	-	-	-
PR-150	.021	.031	.033	.056	.093	-	-	-	-	-	-	-	-	-	.028	.082	.107	.161	.225	.375	-	-	-	-	-	-	-	-	-
PR-151	.018	.029	.037	.042	.053	.089	-	-	-	-	-	-	-	-	.028	.057	.121	.176	.214	.330	-	.03	.03	.03	.03	.03	.03	.03	.03
PR-152	.018	.029	.037	.042	.053	.089	-	-	-	-	-	-	-	-	.046	.059	.10	.151	.217	.302	.335?	.4	.20	.20	.20	.20	.20	.20	.20
PR-153	.014	.028	.033	.048	.063	.08	.143	-	-	-	-	-	-	-	.05	.095	.118	.171	.272	.351	-	-	-	-	-	-	-	-	-
PR-154	.014	.028	.036	.053	.077	-	12	18	21	26	27	34	-	-	.063	.097	.118	.168	.311	.368	.272	.16	.9	.23	.31	.31	.31	.31	.31
PR-155	.015	.026	.031	.048	.071	.086	.112	-	-	-	-	-	-	-	.063	.097	.118	.168	.311	.368	.272	.16	.9	.23	.31	.31	.31	.31	.31



## OSTRACODA

### Introduction

Fourteen species of ostracods are described from the Upper Mattson Formation on Tika Creek. Of these, seven are new.

The classification adopted is that proposed by Benson et al. (1961).

Phylum Arthropoda

Class Crustacea

Subclass Ostracoda

Order Palaeocopida

Suborder Beyrichicopina

Superfamily Youngiellacea

Family Youngiellidae

Genus Glyptopleuroides Croneis and Gale, 1939

Glyptopleuroides sp. A

Plate 2, figures 8-9

The valves are small, elongate, and have a subrhomboidal lateral outline. The hinge line is straight. The posterior cardinal angle is distinct, measuring about 80 degrees, while the anterior measures about 105 degrees and is bluntly rounded. The antero-dorsal margin is steeply inclined and curves abruptly into the ventral. The posterior margin is steep and curves smoothly into the almost straight ventral. The valves are bluntly wedge-shaped in dorsal view. Both the ventral and dorsal surfaces are fairly broad



and flattened. The greatest height is medial, while the greatest width is behind mid-length.

A major groove parallels all margins and defines a prominent rim. A secondary groove begins below mid-anterior, curves up slightly above mid-height and terminates posterior to mid-length. A few small longitudinal ridges branch off and terminate in the grooves.

The dimensions of figured specimen U. of A. No. PR-122 are: length, 0.74 mm.; height, 0.41 mm.; estimated width, 0.39 mm.

#### Horizon and Locality.

Poorly preserved isolated valves of this species are fairly abundant on the Tika Creek section in the interval 280 to 300 feet below the top.

Suborder Kloedenelloccopina

Superfamily Paraparchitacea

Family Paraparchitidae

Genus Pseudoparaparchites Kellet, 1933

Pseudoparaparchites sp. A

Plate 2, figures 10-13

The carapace is small and elongate ovate to subtrapezoidal in lateral outline. The dorsal margin is slightly concave to straight. The anterior margin is rather narrowly rounded, meeting the dorsal margin abruptly while curving smoothly into the ventral. The convex ventral margin curves evenly from mid-ventral to the posterior cardinal



angle which makes an abrupt angle with the dorsal margin. The dorsal outline is slightly wedge-shaped. The greatest width is in the posterior one-half, while the greatest height is slightly anterior to mid-length. The valves are swung slightly forward. The greatest axial length extends from the posterior cardinal angle to mid-anterior.

The posterior cardinal angle is about 80 degrees, while the anterior cardinal angle measures approximately 130 degrees.

A prominent hollow spine arises from the posterodorsal surface of each valve, is directed posterodorsally and slightly laterally, and makes an angle of about 130 degrees with the dorsum. The remainder of the shell is smooth.

The left valve is the larger and overlaps the right on the dorsal and ventral margins, but most prominently on the anterodorsal corner.

The dimensions of figured specimen U. of A. No. PR-124 are: length, 0.70 mm.; height, 0.42 mm.; and width, 0.35 mm.

#### Remarks.

The Tika Creek species is quite similar to Pseudoparaparachites elongatus (Cooper), but has more overlap and more erect spines. The genoholotype, P. kansensis Kellet, from the Permian of Kansas, differs in having a bluntly rounded anterior margin and spines which appear to be higher on the valve thus creating the impression of rising from the dorsum and not grading into the lateral surfaces as in the Tika Creek specimens.

#### Horizon and Locality.

Only two carapaces of this species were recovered. These



were from 300 feet below the top of the Tika Creek section.

Order Podocopida

Suborder Podocopina

Superfamily Bairdiacea

Family Bairdiidae

Genus Bairdia McCoy, 1844

Bairdia sp. cf. B. matfieldensis Upson, 1933

Plate 2, figures 17-18

cf. Bairdia matfieldensis Upson. 1933, p.18, Pl.1, figs. 7a,b.

The carapace is medium in size, elongate, and subtriangular to subelliptical in lateral profile. The greatest length is about medial. The dorsal margin is broadly convex from the anterior acumination to the slight concavity just above the posterior acumination. The anterodorsal slope is weakly defined from the rest of the dorsal margin and is convex. The anterior margin is broadly rounded and curves smoothly from its slight acumination into the ventral margin. The venter is straight except for the middle one-third which is concave. The posterior acumination is sharp and very slightly upturned. The dorsal outline is symmetrical with sharp extremities. The greatest width occurs slightly posterior to mid-length, while the greatest height is approximately medial.

The surfaces of the valves are smooth. The left valve being the larger, overlaps the right dorsally and slightly on the concavity of the venter.



The dimensions of the figured specimen U. of A. No. PR-126 are: length, 1.71 mm.; height, 0.81 mm.; and width, 0.51 mm.

Remarks.

Bairdia matfieldensis Upson was described from the Upper Wolfcampian of Nebraska, and although being somewhat smaller is very similar to the Tika Creek specimen.

Horizon and Locality.

This species is rare on the Tika Creek section, as only one complete carapace and several fragments were recovered. They occur in the interval 280 to 300 feet below the top of the section.

Bairdia sp. cf. B. hurwitzi Coryell and Booth, 1933

Plate 2, figures 14-16

cf. Bairdia hurwitzi Coryell and Booth. 1933, p.262, Pl. 3, figs. 8, 9.

cf. Bairdia beedei Ulrich and Bassler. Kellett, 1934, p.123, Pl.14, figures 1a-h, 2.

cf. ?Bairdia beedei var. inflata Payne. 1937, p.283, Pl. 39, figs. 2a, b.

cf. Bairdia hurwitzi Coryell and Booth. Sohn, 1960, pp.21, 27.

The carapace is small, short, stout, and subrhomboidal in lateral outline. The dorsal margin is strongly arched, with a slight concavity on the posterodorsal slope. The anterior margin is broadly rounded, slightly truncate, and curves into the convex ventral margin which has a marked concavity medially. The posterior acumination



occurs about one-third the maximum height. The greatest length is in the ventral one-half of the carapace, while the greatest width is posterior to mid-length. The maximum height is anterior to mid-length.

The valves are smooth. The left valve is the larger, and overlaps the right on all margins but is most pronounced antero-dorsally and mid-ventrally. The hinge is incised in the posterior half of the dorsum.

The dorsal outline is stout, <sup>symmetrical</sup>, and with pointed extremities.

The dimensions of figured specimen U. of A. No. PR-127 are: length, 0.87 mm.; height, 0.59 mm.; and width, 0.45 mm.

Remarks.

The Tika Creek specimens most closely resemble Bairdia beedei var. inflata Payne, but differ in having less overlap and a very slight concavity on the anterodorsal slope. Sohn (1960, p. 28), considered Payne's specimens to be juveniles of B. hurwitzi. The Tika Creek specimens are also juveniles. Bairdia beedei Ulrich and Bassler has a straighter dorsum on the right valve, is larger, and has better defined cardinal angles than the Tika Creek specimens.

Horizon and Locality.

Bairdia sp. cf. B. hurwitzi is rare on the Tika Creek section, as only three immature carapaces and a few fragments were recovered. They occurred in the interval 280 to 300 feet below the top of the Tika Creek section.



Suborder Metacopina

Superfamily Healdiacea

Family Healdiidae

Genus Healdia Roundy, 1926

Healdia subangularis Delo, 1930

Plate 3, figures 1-4

Healdia subangularis Delo. 1930, p.169, Pl. 13, fig. 6.

The carapace is small, elongate, and subelliptical in lateral outline. The dorsal margin is broadly convex, with the dorsal part of the hinge incised. The greatest height is behind mid-length. The anterior margin is evenly rounded, while the posterior is almost vertical but appears to be swung to the posterior. The ventral margin is straight to very slightly concave. The greatest length is medial, while the greatest width is just posterior to mid-length.

The anterior cardinal angle measures about 135 degrees, while the posterior is about 100 degrees.

Two posteriorly directed spines arise close to the postero-dorsal and posteroventral corners and extend slightly beyond the posterior margin. The dorsal spine arises anterior to the ventral. They begin as low ridges in the posterior one-third of the valves and merge into a spine, while the ridge itself swings around to follow the posterior margin and unite the two spines. A small triangular depression occurs between the spines. The ventral ridge runs up towards the anterodorsal corner before disappearing in the



posterior one-third of the shell, slightly below mid-height.

The left valve is the larger and overlaps the right on the venter and anterodorsal corner, and only slightly on the anterior margin.

The dorsal outline is symmetrical and wedge-shaped.

The dimensions of figured specimen U. of A. No. PR-127 are: length, 0.55 mm.; height, 0.3 mm.; and width, 0.23 mm.

Remarks.

The Tika Creek specimens are smaller than Healdia subangularis Delo but in all other respects are very similar, especially in the nature of the posterior spines. Healdia subangularis was described from the Pennsylvanian of Texas.

Horizon and Locality.

This species is quite common between 280 and 300 feet on the Tika Creek section.

Healdia sp. A

Plate 3, figures 5-8

The carapace is small and subtriangular in lateral outline. The dorsal margin is strongly arched with the longer posterodorsal slope slightly concave. The maximum height is anterior to mid-length. The anterior margin is broadly rounded, curving into the straight to slightly concave ventral margin. The posterior margin is more sharply rounded. The greatest length is medial, while the greatest width is near the posterior due to a slight inflation.

The posterior cardinal angle measures about 150 degrees,



while the anterior is obtuse but poorly defined.

Two stout posteriorly directed spines arise from the posterodorsal and posteroventral surfaces of each valve, but do not extend to the posterior margin. They are inclined at about 10 degrees to the dorsal and ventral margins. In some specimens there appears to be a thin poorly defined ridge very close to the anterior margin and parallel to it. The remainder of the carapace is smooth.

The left valve is the larger and overlaps the right on all margins except the posterodorsal slope where the hinge is slightly incised.

The muscle scar is a circular cluster of about 30 spots positioned slightly anterior at mid-height.

The dimensions of figured specimen U. of A. No. PR-130 are: length, 0.99 mm.; height, 0.64 mm.; and width, 0.41 mm.

Remarks.

A similar species is H. chapmani Crespin of the lower Permian of eastern Australia, but which is smaller and has thinner spines than the Tika Creek species. Other similar species are H. spinosa Cooper and H. limacoidea Knight but which are smaller, have less overlap, and a less highly arched dorsum.

Horizon and Locality.

This species is very abundant on the Tika Creek section occurring in the interval 280 to 300 feet below the top of the section.

Genus Waylandella Coryell and Billings, 1932



Waylandella sp. A

Plate 3, figures 9-11

The carapace is small and subelliptical to ovate in lateral outline. The dorsal margin is broadly convex. The greatest height is posterior to mid-length. The anterior margin is narrowly rounded, curving smoothly into the convex venter. The medial one-third of the venter is straight. The posterior margin is broadly rounded with a slight truncation defining a fairly sharp posteroventral corner. The dorsal outline is lanceolate. The greatest length is medial, while the greatest width is posterior to mid-length.

The posterior cardinal angle is about 70 degrees while the anterior is not well defined.

Two spines arise close to the posterodorsal and ventral corners but which are very small and would be imperceptible if not for the small ridge supporting them. The dorsal spine begins slightly further anterior than the ventrals. The remainder of the carapace is smooth.

The hingement is formed by simple overlap and the postero-dorsal part of the hinge line is incised.

The left valve is the larger, overlapping the right considerably on the venter and to a lesser degree on all other margins.

The muscle scar is a circular cluster of more than 20 spots and is medial, slightly above mid-height.

The dimensions of figured specimen U. of A. No. PR-132 are: length, 0.81 mm.; height, 0.52 mm.; and width, 0.37 mm.



Remarks.

The characteristic features of this species are its very smooth outlines, conspicuous overlap, and incipient spine development.

Horizon and Locality.

Two carapaces were collected of this species at 300 feet below the top of the Tika Creek section.

Waylandella sp. B

Plate 3, figures 12-14

The carapace is small in size, elongate, and ellipsoidal to ovate in lateral outline. The dorsal margin is moderately arched, the anterior slope being the longer. The maximum height is posterior to mid-length. The anterior margin is narrowly rounded, curving evenly into the dorsal and ventral margins. The posterior margin is more broadly rounded and slightly truncate, the dorsal and ventral angles being about equal. The venter is convex with a small inflection in the center and somewhat angled at the anterior corner. The dorsal outline is elongate ovate, symmetrical with pointed extremities. The greatest width is posterior due to an inflation, while the greatest length is just above mid-length.

The posterior cardinal angle is about 135 degrees, the anterior however is not well defined.

A poorly developed ridge runs approximately parallel to the posterior margin but is straighter and inclined forward. The ridge curves smoothly into the dorsal margin and meets the ventral at a sharp angle posterior to mid-length. The dorsal and ventral



ends of the ridge are thickened, indicating a very weak spine development. A fairly steep slope extends from the ridge to the posterior margin. The remainder of the shell is smooth.

The left valve is the larger, and overlaps the right on the venter and slightly on the posterior and anterodorsal margins. The posterodorsal margin is incised along the hinge line.

The muscle scar is circular, is located medially, and consists of more than 20 spots the outer ones being elongated somewhat radially.

The dimensions of figured specimen U. of A. No. PR-133 are: length, 0.87 mm.; height, 0.48 mm.; and width, 0.37 mm.

Remarks.

Waylandella sp. B resembles some species of Healdia, especially H. diversus Coryell and Rozanski but more elongate and somewhat pointed posteroventrally, thus placing it in the genus Waylandella.

Horizon and Locality.

This species is fairly rare on the Tika Creek section, occurring from 280 to 300 feet below the top of the section, where only carapaces were recovered.

Genus Healdioides Coryell and Rozanski, 1942

Healdioides sp. A

Plate 3, figures 15-17

The carapace is small in size, and subovate to subtriangular



in lateral outline. The maximum height is anterior to mid-length. The dorsum is fairly strongly arched, with the posterodorsal slope the longer and which is very slightly concave. The anterior margin is broadly rounded, curving into the concave to convex ventral margin. The posterior margin is more narrowly rounded with fairly sharp angulation at the posterodorsal corner. The dorsal outline is sublanceolate. The greatest length is medial, and the greatest width is posterior due to an inflation in the posterior portion of the shell.

The posterior cardinal angle is about 135 degrees, while the anterior is not well defined.

A low ridge begins at the dorsal margin in the posterior one-third and curves smoothly into the posterior quarter of the valve and then turns more abruptly into the ventral margin meeting it posterior to mid-length. The posterodorsal and particularly the posteroventral angles are slightly swollen suggesting incipient spine development. A weak rim borders the posterior and postero-ventral margins. The remainder of the shell is smooth.

The left valve is the larger, overlapping the right on all margins but the anterior. The posterodorsal slope is incised.

The muscle scar is a circular cluster of 20 or more spots and is medial, about mid-height.

The dimensions of figured specimen U. of A. No. PR-134 are: length, 0.88 mm.; height, 0.59mm.; and width 0.41 mm.



Remarks.

A quite comparable species is H. simplicissima Harlton but which has a shorter and less strongly curved posterior ridge.

Horizon and Locality.

Healdioides sp. is very abundant on Tika Creek in the interval 280 to 300 feet below the top of the section.

Genus Seminolites Coryell, 1928

Seminolites sp. A

Plate 3, figures 18-21

The carapace is small, elongate, and subelliptical in lateral outline. The dorsal margin is broadly convex and the anterior slope is the steeper. The position of greatest height is about medial. The anterodorsal slope turns sharply into the narrowly rounded anterior margin which curves smoothly into the straight to slightly concave ventral margin. The posterior margin is narrowly rounded, slightly truncate, and joins the ventral margin at a fairly sharp angle. The greatest length is below mid-length, while the greatest width is posterior to mid-length.

The posterior cardinal angle is about 110 degrees, while the anterior is about 125 degrees but is not well defined.

A sharp dorsal ridge begins slightly posterior to mid-length and runs straight almost to the posterior margin where a small sharp spine arises. The ridge then swings parallel to the posterior margin and very abruptly curves to parallel the ventral, extending again to almost mid-length. The inner edges of the ridge are



paralleled by a shallow groove which becomes obsolete in a broad depressed area inside the posterior portion of the ridge. A few pits occur slightly anterior to this depression between the dorsal and ventral portions of the ridge. A low ridge very close to the anterior margin runs from the anterodorsal corner to the venter and disappears in the anterior one-third of the shell.

The left valve is the larger and overlaps the right extensively on the anterior and anteroventral margins, and elsewhere only slightly. The hinge line is incised on the posterodorsal margin.

The dimensions of figured specimen U. of A. No. PR-135 are: length, 0.55 mm.; height, 0.26 mm.; and width, 0.18 mm.

**Remarks.**

The distinguishing features of this species are its elongate outline, sharp ridge, and few pits in the posterior portion.

**Horizon and Locality.**

This species is very rare on Tika Creek as only two specimens were encountered. They occurred at 300 feet below the top of the section.

**Family Bairdiocyprididae**

Genus Pseudobythocyparis Shaver, 1958

Pseudobythocyparis pediformis (Knight), 1928

Plate 3, figures 22-24

Bythocyparis pediformis Knight, 1928, p.326, Pl. 44, fig. 3.



Bythocypris parallela Knight, 1928, p.327, Pl.44, fig. 2

Healdia leguminoides Knight, 1928, p.332, Pl. 44, fig. 7

The carapace is small, elongate, and ovate to subelliptical in lateral outline. The dorsal margin is broadly arched and both anterior and posterior slopes are about equal. The maximum height is anterior to mid-length. The anterior margin is narrowly rounded and slightly more angular at the ventral corner. The posterior margin curves fairly uniformly into an abrupt corner at the ventral margin. The ventral margin is straight with a concavity in the middle one-third. The dorsal outline is symmetrical, elongate ovate with pointed extremities. The greatest width is medial, and the greatest length is a line from the posteroventral corner to mid-anterior.

The cardinal angles are poorly defined. The surface is entirely smooth. The left valve is the larger and overlaps the right on the posterior and ventral margins, but only slightly on the dorsal and anterior.

The muscle scar is a circular aggregate of 10 to 12 spots and is located approximately medially.

The dimensions of figured specimen U. of A. No. PR-136 are: length, 0.66 mm.; height, 0.35 mm.; and width, 0.25mm.

Remarks.

The form ratio of the Tika Creek specimens falls midway between those of P. pediformis and P. parallela. In other features, the three are quite indistinguishable.



Horizon and Locality.

This species is common in the interval 280 to 300 feet below the top of the Tika Creek section.

Family Cavellinidae

Genus Cavellina Coryell, 1928

Cavellina ellipticalis Hamilton, 1942

Plate 3, figures 25-29

Cavellina ellipticalis Hamilton, 1942, p.717, Pl. 110, fig. 7.

The carapace is small, elongate, and subelliptical in lateral outline. The dorsal margin is slightly convex to straight. The greatest height is posterior to mid-length. The anterior margin is broadly rounded but slightly truncated while the posterior margin is more broadly rounded with a vertical middle one-third and a small angulation at the posterodorsal corner. The ventral margin is concave to convex. The dorsal outline is wedge-shaped to subrectangular. The greatest length is just above mid-length while the greatest width is near the posterior end.

The cardinal angles are obtuse, subequal, and rather poorly defined.

The surface is smooth, but juveniles show a low poorly developed ridge near the posterior margin and slight swelling.

The right valve is the larger and overlaps the left on the dorsal and ventral margins, but only slightly elsewhere.

The dimensions of figured specimen U. of A. No. PR-136 are: length, 0.91 mm.; height, 0.47 mm.; and width, 0.33 mm.



Remarks.

The diagnostic features of this species are the overlap, large form ratio, subparallel sides in the adult and more bean-shaped outline in juveniles.

Horizon and Locality.

This species is common between 280 and 300 feet below the top of the Tika Creek section.

Cavellina sp. cf. C. fittsi Kellett, 1935

Plate 3, figures 30-34

cf. Cavellina fittsi Kellett, 1935, p.147, Pl. 18, figs. 2, 3.

cf. Cavellina fittsi Kellett, McLaughlin, 1952, p.615, Pl. 82, figs. 26, 27.

The carapace is small and longitudinally ovate in lateral outline. The dorsum is broadly convex with the slopes about equal. The greatest height is medial to just posterior to mid-length. The anterior margin is less broadly rounded than the posterior in juveniles, about equal in adults. The posterior margin is bluntly rounded with a small truncation at the posteroventral corner in some specimens. The ventral margin is straight to slightly convex. The dorsal outline is wedge-shaped. The greatest length is just above mid-length while the greatest width is near the posterior margin due to a swelling, after which a steep slope to the posteriormargin occurs.

The cardinal angles are obtuse and poorly defined, the



posterior however measures approximately 120 degrees.

The surface is smooth except for a small ridge near the posterior margin in some specimens.

The right valve is the larger, overlapping the left on the ventral, dorsal, and posterior margins, and absent or slightly reversed on the anterior margin. The muscle scar was not seen.

The dimensions of figured specimen U. of A. No. PR-138 are: length, 1.01 mm.; height, 0.6 mm.; and width, 0.43 mm.

Remarks.

This species is distinguished from C. ellipticalis in its greater size, more extensive overlap, and smaller form ratio. Cavellina fittsi Kellett has a slightly smaller form ratio and lacks the posterior swelling as observed in the Tika Creek specimens.

Horizon and Locality.

This species is very abundant in the interval 280 to 300 feet below the top of the Tika Creek section.

Superfamily Quasillitacea

Family Quasillitidae

Genus Graphiadactylis Roth, 1929

Graphiadactylis sp. A

Plate 3, figures 35-38

The carapace is large, elongate, subelliptical in lateral outline, and is swung anteriorly. The greatest height is in the anterior one-quarter. The dorsal margin is straight. The anterior



margin is sharply defined from the dorsal, is straight to a small accumulation occurring below mid-height and curves more broadly into the venter. The posterior margin is more acutely defined from the dorsum and curves broadly into the venter. The ventral margin is slightly convex to straight with a slight inflection in the middle. The dorsal outline is elongate elliptical with fairly sharply pointed extremities. The longest axis extends from slightly below midanterior to the posterodorsal corner. The greatest length is below mid-height while the greatest width is posterior to mid-length.

The cardinal angles are distinct with the anterior measuring about 130 degrees, the posterior about 110 degrees.

The surface has a barely discernible ornament of the typical "finger-print" pattern characteristic of the genus. A very slight anteroventral frill is also present, although much reduced.

The hinge is long, less than the maximum length, and channelled most of its length but with minor overreach at the anterior and posterior corners.

The left valve is the larger and overlaps the right on the ventral and posterior margins, and to a lesser degree on the anterior and dorsal cardinal corners.

The muscle scar is a cluster of about 20 spots in a smooth round field, slightly dorsal and anterior to the mid-length of the valves.

The dimensions of figured specimen U, of A. No. PR-140



are: length, 1.50 mm.; height, 0.87 mm.; width, 0.68 mm.; and hinge length, 1.03 mm.

Remarks.

The diagnostic features of this species are its reduced ornament and frill, and large size.

Horizon and Locality.

This species is abundant in the interval 280 to 300 feet below the top of the Tika Creek section. Three carapaces were recovered as well as many fragmentary remains.



## FORMAL DESCRIPTIONS OF MEGAFOSSILS

### Introduction

Twenty-three Lower Permian brachiopods and one gastropod are described from the upper portion of the Mattson Formation on Tika Creek. Their stratigraphic range is recorded in the Upper Limestone Unit on Tatonduk River.

Principal works used in the identification of the brachiopods were: Tschernyschew (1902), Dunbar (1955) and Harker (1960). The classification of the productid brachiopods is that proposed by Muir-Wood and Cooper (1960). Shrock and Twenhofel's classification (1953) was adopted for the remainder.

Specimens recorded as "U. of A.", were placed in the collections of the University of Alberta. The majority of figured and described specimens were on loan from Shell Oil Company of Canada Limited and were recorded in the descriptions with the prefix "SH".

Phylum Brachiopoda

Class Articulata

Order Protremata

Suborder Productoidea

Superfamily Productacea

Family Dictyoclostidae

Genus Dictyoclostus Muir-Wood, 1930

Dictyoclostus neoinflatus (Licharew), 1939

Plate 4, figures 1-4

Productus inflatus McChesney. Tschernyschew, 1902, p.612, Plate 28, figs.1-6.



Productus (Productus) arcticus Whitfield. Stepanov, 1937, p. 113,  
Plate 2, figs. 9,10.

Productus (Productus) arcticus Whitfield. Einor (partim), 1939, p.47,  
Plate 8, fig. 4.

Productus neoinflatus Licharew, 1939, p.90, Plate 21, figs. 2,3.

Dictyoclostus sp. cf. D. neoinflatus Licharew. Harker (partim), 1960,  
p.55, Plate 17, fig. 3.

The description is based on SH-8018-1, a ventral valve, and  
SH-8018-2 showing dorsal features.

The shell is medium sized and subtrapezoidal to subtriangular  
in outline. The width near the anterior margin is 45 mm., the hinge-  
width is 30 mm., while the length is 31 mm.

The ventral valve is subtriangular in outline, has a minor  
medial sulcus, a steep convex profile and steep flanks. The geniculation  
is very abrupt near the anterior margin. In well preserved specimens,  
spine bases are regularly distributed over the visceral hump and flanks,  
and are absent medially beyond the hump. Spine base diameters are  
approximately 1/2 mm. and the distance between them averages 5 to 6 mm.  
Costae bifurcate until they number about 9 per 10 mm. near the anterior  
margin. Rugae are restricted to the posterior portion of the valve and  
are obsolete on the trail where the costae become very straight and  
regular. The beak is fairly well rounded, slightly incurved, and extends  
somewhat beyond the hinge line.

The dorsal valve is subtrapezoidal in outline and slightly  
concave with a very small medial fold beginning about 9 mm. from the  
hinge line. The surface is highly reticulate with the costae becoming  
obsolete on the geniculated portion of the lateral margins. Spine bases



are few and irregularly distributed.

Remarks.

This species is characterized by its very abrupt geniculation, steep flanks, and fairly coarse, regular ventral costae.

The Tika Creek specimens, in general, lack the preservation of auricles, but in all other respects agree quite well with Licharew's holotype.

Horizon and Locality.

Dictyoclostus neoinflatus is abundant 243 to 300 feet below the top of the Tika Creek section and is common in the Upper Limestone Unit of Tatonduk River between 1270 and 1430 feet.

Dictyoclostus sp. cf. D. boliviensis (d'Orbigny), 1842

Plate 4, figure 5

cf. Productus boliviensis d'Orbigny. Tschernyschew, 1902, p.607, Plate 35, fig. 3; Plate 32, fig. 5.

cf. Productus boliviensis d"Orbigny. Licharew, 1939, p.92, Plate 21, fig. 5.

Dictyoclostus sp. cf. D. neoinflatus Licharew. Harker (partim), 1960, p.55, Plate 17, figs. 1, 2.

Specimens of this species on the Tika Creek section are represented by ventral valves only. The description is based on SH-8018-3, a fairly complete valve, and SH-8018-4, a partial shell showing details of the hinge line and ornamentation.



The shell is large and subcircular to subrectangular in outline. The width near the anterior margin is about 45 mm. while the observed width at the hinge is 40 mm. The length of the shell is estimated as 40 mm.

The profile of the ventral valve is very convex in the beak area and on the skirt, but flattens somewhat over the visceral hump. The geniculation begins about 32 mm. from the beak and the shell curves with fair rapidity into the long trail. A small broad medial sulcus begins about 15 mm. from the beak and extends to the end of the trail. Spine bases are sparse, have a diameter of from 1/2 to 1 mm., and are irregularly scattered over the valve with some preferential distribution on the flanks near the hinge line. Anterior costae number 10 to 11 per 10 mm., and are obsolete on the flanks. Rugae extend 23 to 28 mm. anteriorly and reach about 8 per 10 mm. over the visceral hump. The beak is fairly well rounded, extends slightly beyond the hinge line, and is incurved.

#### Remarks.

This species differs from D. neoinflatus in its less acute geniculation, less steep flanks, and finer costae. Licharew's specimens differ from the Tika Creek specimens in being somewhat more inflated over the visceral hump.

#### Horizon and Locality.

Dictyoclostus sp. cf. D. boliviensis is a rare species, occurring at 300 feet on the Tika Creek section and at 1270 feet on the Tatonduk River section.



Genus Muirwoodia Licharew, 1947

Muirwoodia greenlandica Dunbar, 1955

Plate 4, figures 6-8

Muirwoodia greenlandica Dunbar, 1955, p.103, Plate 16, figs. 1-17

Muirwoodia greenlandica Dunbar, 1961, p.226, Fig. 1, figs. 3-6.

The collections from the Upper Mattson Formation consist of ventral valves only. The description is based on SH-8018-5, an almost complete specimen.

The shell is small to medium in size and has a subrectangular outline. The maximum observed width is 39 mm. along the hinge line, while the length is 24 mm.

The ventral valve is inflated over the visceral hump, and has a subrectangular outline. A narrow sulcus begins 4 mm. from the beak and expands in width over the trail. The hinge line is straight with the small pointed beak extended slightly beyond it. A few laterally directed spine bases are scattered on the margin of the hinge with a large one on each extremity. Two large perpendicular spine bases per hump occur on the anterior trail. The shell is very strongly arcuate and geniculate but tends to flatten out on the incurved trail. Rounded fine costae cover the valve and average about 16 per 10 mm. on the skirt. Rugae are rather weakly developed over the visceral humps and absent on the trail.

Remarks.

The diagnostic features of this species are its long hinge line, relatively large size, and large spines on the anterior humps. The Tika Creek specimens are somewhat smaller than the holotype, but are identical in other respects, in spite of the fact that it is defined as having only one major spine per hump near the anterior margin.



Muirwoodia greenlandica differs from M. mammatus in being thicker shelled and lacking the horizontally orientated spines near the anterior margin. Similarly, it differs from M. transversa Cooper in having a less pronounced geniculation and a smaller size, although the latter feature is a rather poor criterion.

Horizon and Locality.

Muirwoodia greenlandica is fairly rare on the Tika Creek section at 300 feet, but is somewhat more abundant on the Tatonduk River section in the interval 1270 to 2400 feet.

Family Echinoconchidae, Stehli, 1954

Genus Waagenoconcha Chao, 1927

Waagenoconcha sp. cf. W. irginae (Stuckenbergs), 1898

Plate 4, figures 9-11

cf. Productus irginae Stuckenbergs, 1898, p.127, Plate 2, fig. 16a

cf. Productus irginae Stuckenbergs. Tschernyschew, 1902, p.618, Plate 52, figs. 1-4.

cf. Productus (Waagenoconcha) irginae Stuckenbergs. Frebold, 1937, p.18, Plate 5, fig. 8

cf. Productus (Waagenoconcha?) irginae Stuckenbergs. Einor, 1939, p.33, Plate 3, fig. 12; Plate 4, figs. 1-4

The description is based on SH-8018-6, a ventral mould and SH-8018-7, a dorsal impression.

The shell is large and subtrapezoidal in outline. The maximum length is 46 mm. and maximum width is 61 mm. slightly anterior to the hinge line.



The ventral valve has a low convex profile and is subtrapezoidal in outline. Numerous spine bases indicate the spines rose tangentially and became progressively smaller towards the anterior and lateral margins, as is typical of the genus. A shallow sulcus begins near the beak and broadens anteriorly. There is a vague development of rugae in the umbonal region.

The dorsal valve is subrectangular in outline, very slightly concave, and covered with many spine bases which become progressively smaller towards the anterior. A few spine impressions are present in the host sediment indicating lateral marginal spines are slender, pointed, and about 4 to 5 mm. in length. There is a shallow broad fold beginning near the hinge line and becoming obscure about one-third the length from the beak.

#### Remarks.

The Tika Creek specimens are somewhat smaller and perhaps broader than those figured by Frebold and Tschernyschew, but in other respects are quite comparable. Waagenoconcha irginae differs from W. payeri (Toula) in being less elongate and convex, although specimens figured by Harker (1960) and Dunbar (1955) are comparable in size.

#### Horizon and Locality.

This species is rare on the Tika Creek section, occurring 300 feet below the top of the measured section. It is present on the Tatonduk River section in the interval 760 to 2460 feet.

Genus Kochipructus Dunbar, 1955

Kochipructus freboldi (Stepanov), 1937



Productus porrectus Kutorga. Tschernyschew, 1902, p. 634, Plate 55

fig. 1; Plate 56, fig. 4; Plate 62, fig. 2

Productus porrectus Kutorga. Frebold, 1933, p.13, Plate 1, fig.1

Productus (Buxtonia) freboldi Stepanov, 1937, p.122, Plate 2, fig. 4

Productus cf. porrectus Kutorga. Fr**e**bold, 1938, p.19, Plate 1, figs. 6,7

Kochiproductus freboldi (Stepanow). Harker, 1960, p.59, Plate 17,  
figs. 6,7

The description is based on a complete specimen, U. of A.

No. PR-114.

The specimen is subtriangular to subpentagonal in outline and its major convexity is expressed in the beak area. A sulcus begins about 6 mm. from the beak and broadens anteriorly but remaining fairly shallow. About 9 ribs per 10 mm. occur near the anterior margin, and are interrupted frequently by coarse and medium rugae giving a reticulate appearance to the valve. A multitude of very fine growth lirae also cover the shell. Spine bases are very irregularly placed, on the anterior skirt and flanks near the hinge line, and indicate that the spines rose perpendicularly from the shell surface.

The dorsal valve is planar to slightly concave, subtrapezoidal in outline, with a small fold from the beak to about mid-length. Spine bases are slightly more numerous than on the ventral valve and are generally concentrated anteriorly. Ribs number about 9 to 10 per 10 mm. towards the anterior margin and tend to disappear on the flanks. They are interrupted frequently by coarse rugae, imparting a strong reticulate pattern to the valve.



Remarks.

The Tika Creek specimens agree in all features with K. freboldi Harker except they are almost half the size. Kochipructus freboldi differs from Kochipructus plexicostus Dunbar in having simpler rib patterns and larger size generally. In other respects the two species are very similar and may therefore, be conspecific.

Horizon and Locality.

Kochipructus freboldi is abundant at 243 to 300 feet below the top of the Tika Creek section and was recovered in the interval 2150 to 2460 feet on the Tatonduk River section.

Genus Echinoconchus Weller, 1914

Echinoconchus inexpectatus Cooper, 1957

Plate 5, figures 1-4

Echinoconchus inexpectatus Cooper, 1957, p.48, Plate 8, figs. 13-26

The description is based on U. of A. No. PR-111, a ventral valve; SH-8018-9 showing dorsal features; and SH-8018-10, a ventral valve with the spines preserved.

The shell is small to medium in size and subtriangular to subpentagonal in outline. The three specimens have an average length of 24 mm. and a maximum width of 31 mm. just anterior to midlength.

The ventral valve is subtriangular to subpentagonal in outline and is rather broadly convex. The convexity decreases anteriorly as the shell develops a short tail. The beak is pointed, well incurved, and extends 3 mm. beyond the hinge line. The auricles are small, triangular,



and fairly flat. A poorly expressed sulcus begins about 6 mm. from the beak imparting a very weak bilobed appearance to the valve. In many specimens, this is accentuated by crushing. The surface is ornamented with large regularly spaced concentric growth lines about 2 to 4 mm. apart. Spines are of two sizes: the smaller irregularly distributed on the posterior slopes of the concentric bands, while the larger occur between the bands and are very regularly positioned in quincunx, making an angle of 30 to 45 degrees with the bands. The spines are prostrate and become much larger and more irregularly distributed anteriorly.

The dorsal valve is flat to slightly concave with the anterior margin curving slightly ventrally. It is subtrapezoidal in outline and has a bilobed appearance due to a sulcus near the beak which yields to a broad shallow fold towards the anterior. Postero-lateral depressions extend from the sides of the visceral area to the hinge. The ornament is banded in the same manner as the ventral valve.

Remarks.

Echinocionchus inexpectatus is similar to E. fasciatus (Kutorga) but differs in having a rectangular dorsal outline, a less convex profile, and slightly narrower spacing of the concentric bands.

Horizon and Locality.

Echinocionchus inexpectatus is fairly abundant at 300 feet below the top of the Tika Creek section where most specimens are crushed. It is present on the Tatonduk River section in the interval 1430 to 1460 feet.



Family Linoprotidae Stehli, 1954

Genus Cancrinella Fredericks, 1928

Cancrinella cancriniformis (Tschernyschew), 1889

Plate 5, figures 6-8

Productus cancriniformis Tschernyschew, 1902, p.292, Plate 52, figs. 5,6

Productus (Linoprotus) janischewskianus Stepanov, 1939, p.178, Plate 3, fig. 7

Productus (Productus) cancriniformis Tschernyschew. Einor, 1939, p.45, Plate 7, figs. 3,4

The description is based on SH-8019-1, a ventral valve.

The shell is of medium size and subcircular in outline. The greatest width is 28 mm. just anterior to the midline, while the maximum observable length is 24 mm.

The ventral valve is convex, most sharply in the beak area. The beak is fairly stout, tapers rapidly, and is strongly incurved. The auricles are small and flat, while the flanks of the umbo are flaring. The ornament consists of radial branching and intercalating costae which reach a maximum of 20 to 21 per 10 mm. near the anterior margin. Discontinuous large rugae are irregularly distributed over the valve becoming less frequent anteriorly where two occupy 3 mm. A few large spine bases are concentrated mainly in the posterior part of the valve and are spaced about 6 mm. apart. Small irregularly distributed spine bases are present along the hinge line.

Remarks.

A distinctive feature of this species is its coarse irregular



rugae over the visceral hump. Cancrinella cancrini (deVerneuil) is a similar species but lacks these characteristic rugae.

Horizon and Locality.

Cancrinella cancriniformis occurs in the Tika Creek section at 243 to 300 feet below the top, where it is rare. A similar specimen was found in the Tatonduk River collections at 3050 feet below the top of the measured section. This species is known to be long ranging, and although being quite distinctive it is of little use in correlation work.

Genus Linopproductus Chao, 1927

Linopproductus sp. cf. L. tenuistriatus (deVerneuil), 1845

Plate 5, figures 13-14

cf. Productus tenuistriatus deVerneuil, 1845, p.206, Plate 16 fig. 6

cf. Productus tenuistriatus deVerneuil. Tschernyschew, 1902, p.288,  
Plate 45, fig. 6

The ~~description~~ is based on SH-8018-11, an incomplete ventral valve showing details of the ornamentation and beak.

The shell is subcircular in outline, inflated, and very convex in the beak area becoming less so anteriorly. The maximum estimated width is 46 mm. just anterior to midlength. The maximum length is 38 mm.

The ventral valve is subcircular in outline and fairly well inflated. Rounded costae number about 16 per 10 mm. on the trail. They have a characteristic wiggle towards the anterior margin and increase by intercalation in this direction. A few minor rugae are confined mainly to the flanks in the umboinal region. A multitude of extremely fine



concentric growth lirae cover the shell. The beak is small, blunt, and strongly incurved. A few spine bases are present along the hinge line.

Remarks.

A great many species have been erected within this genus based on the ornamentation and shape of the valves. A number of these characteristics may not, however, be of specific importance. For example, Grabau (1936), states L. tenuistriatus differs from L. simensis in having a less incurved beak and lacking the posterior flattening of the visceral hump. His figures however, (Plate 12, figs. 10-15), show both a flattened and convex hump included in L. simensis. Linoprotodus tenuistriatus differs from L. aagardi (Toula) in having much coarser costae, and from L. cora (d'Orbigny) in its smaller size and greater convexity.

Horizon and Locality.

Linoprotodus sp. cf. L. tenuistriatus is poorly preserved but very abundant on the Tika Creek section at 243 to 300 feet below the top. A comparable species was encountered on the Tatonduk River section in the interval 2150 to 2310 feet.

Family Marginiferidae Stehli, 1954

Genus Spinomarginifera Huang, 1932

Spinomarginifera n. sp. A

Plate 5, figures 9-12

The description is based on SH-8018-13, a specimen showing both dorsal and ventral features.

The shell is rather small and subquadrate in outline. The



hinge line is straight and the maximum width of 23 mm. occurs just slightly anterior to it. The length is 13 mm.

The ventral valve is subquadrate in outline and fairly well inflated over the visceral region until it reaches the abrupt geniculation, occurring 12 mm. from the beak. A row of about 12 regularly spaced fairly coarse spine bases 2 to 3 mm. apart separates the visceral region from the trail. There is also a row of spine bases on each side of the beak along the hinge line, and a few scattered around the midline over the visceral region. Discontinuous, rounded rugae are confined to the flanks and visceral region and thicken where the spines emerge. Costae are entirely absent on the valve. A weakly developed sulcus begins about 6 mm. from the beak and extends to the anterior margin, imparting a slight bilobed appearance to the shell. This sulcus, however, may be somewhat accentuated by crushing. The beak is pointed and extends slightly over the hinge line. The auricles are small, triangular, slightly convex, and fairly well demarcated from the umbo.

The dorsal valve is gently concave and abruptly geniculated. The ornament consists of irregular concentric rugae. Spines are generally lacking, but a few occur irregularly distributed along the hinge line particularly near the beak.

The interiors of the valves were not seen, but a long thin medial septum in the brachial valve is reflected on the exterior of the valve. Sections of the brachial valve reveal that the margin is a feather-like outgrowth from the valve although they were not at all well preserved.



Remarks

The Tika Creek specimens differ from Huang's (1932) species in the very regularly positioned spines just below the anterior border of the visceral region. The margin has a longer extension than Huang's specimens but seems to be quite comparable.

Horizon and Locality.

This species is common on the Tika Creek section from 243 to 300 feet below the top, but was not encountered in the Tatonduk River collections. The writer has recently noted an occurrence of an almost identical specimen in collections made by Pan American Petroleum Corporation in the Pine Pass area of British Columbia.

Superfamily Chonetacea Shrock and Twenhofel, 1953

Family Chonetidae Hall and Clarke, 1895

Genus Chonetina Krotov, 1888

Chonetina sp. A

Plate 5, figure 5

The description is based on SH-8019-2, a poorly preserved ventral valve.

The valve is subrectangular in outline and has a low convex profile. The maximum width just anterior to the hinge line is 11 mm., while the length is 7 mm. The hinge is straight and a rapidly tapering beak extends very slightly beyond it. A shallow sulcus begins near the beak and broadens anteriorly. The surface ornament was not preserved, but on the exfoliated part of the shell, papillae occur in radial lines.



There are three spine bases on each side of the beak on the hinge margin.

The interior of the ventral valve was poorly preserved, but does show a fairly strong medial ridge.

Horizon and Locality.

One specimen was encountered of this species in the Tika Creek collections from 243 feet below the top. It was not found in the collections from the Tatonduk River.

Superfamily Spiriferacea Waagen, 1883

Family Spiriferidae King, 1846

Genus Squamularia Gemmellaro, 1899

Squamularia rostrata (Kutorga), 1842

Plate 5, figures 15-17

Spirifer rostratus Kutorga, 1842, p.25, Plate 5, fig. 10

Reticularia rostrata (Kutorga). Tschernyschew, 1902, p.194, Plate 15, figs. 4, 5; Plate 20, figs. 14-18

Squamularia rostrata (Kutorga). Grabau, 1936, p.188, Plate 1, fig.7

Neophricodothyris rostrata (Kutorga). Licharew, 1939, p.109, Plate 28, fig. 1

Squamularia rostrata (Kutorga). Cooper, 1957, p.59, Plate 10, figs. 36-42.

The description is based on SH-8018-14, a complete but somewhat squashed shell.

The shell is biconvex, medium in size and suboval to subpentagonal in outline. A width of 29 mm. is attained just posterior to mid-length and the length is 36 mm.



The ventral valve has the greatest convexity in the beak area. The beak is pointed, high and generally erect. Surface ornament consists of regularly distributed concentric bands occurring at a frequency of 1 per 1 mm. near the anterior margin, and have a sharp depression between them. The anterior slopes of the bands are steeper and covered with numerous small spine bases. The gently sloping posterior portions are marked with longitudinal striae which cross the bands and meet the spines on the anterior slopes. The cardinal area is slightly concave and weakly differentiated from the posterior flanks of the shell. The delthyrium is triangular, occupies about one-third of the cardinal area, and has an apical angle of about 60 to 70 degrees.

The dorsal valve is less convex than the ventral and has a more subcircular outline. The beak is bluntly pointed and extends only slightly beyond the hinge line. The ornamentation is the same as on the ventral valve.

Remarks.

The Tika Creek species is nearly twice the size of those figured by Tschernyschew (1902) and Cooper (1957) but agrees very well in outline, profile, and ornamentation. One specimen from the Tatonduk River section is much more comparable in size to Cooper's. The Tika Creek specimens show what appears to be a slight medial sulcus, but sections suggest that this may be due to thinning of the shell in this region.

The genus Neophricodothyris proposed by Licharew (1934), differs from Squamularia by the presence of partitioned tubes passing through the



shell and terminating in spines on the exterior. Thin-sections of the Tika Creek specimens have failed to reveal this structure.

Horizon and Locality.

This species occurs with fair abundance on the Tika Creek section at 300 feet where most specimens are ventral valves. A comparable though much smaller specimen occurs on the Tatonduk River section at 3160 feet.

Genus Spiriferella Tschernyschew, 1902

Spiriferella keilhavii (von Buch) 1848, sensu lato

Plate 6, figures 1-4

Spirifer keilhavii von Buch, 1848, p.74, fig. 2

Spiriferella keilhavii (von Buch). Grabau, 1931, p.164, Plate 21, figs. 1-5; Plate 20, fig. 9

Spiriferella keilhavii (von Buch). Frebold, 1937, p.46, Plate 11, fig. 9

Spiriferella keilhavii (von Buch) sensu lato. Stepanov, 1937 p.143, Plate 7, figs. 8-11

Spirifer (Spiriferella) keilhavii (von Buch) sensu lato. Einor, 1939, p.217, Plate 23, figs. 6,7; Plate 24, figs. 1-9

Spiriferella keilhavii (von Buch). Dunbar, 1955, p.139, Plate 25, figs. 1-9; Plate 26, figs. 1-11; Plate 27, figs. 1-14

Spiriferella keilhavii (von Buch) sensu lato. Harker, 1960, p.72, Plate 23, figs. 1,2; Plate 22, figs. 9-11

The description is based on two almost complete specimens from



the Tika Creek section, SH-8019-3 and SH-8022-1.

The shell is subrounded to subrectangular in outline. The greatest width is 32 mm. slightly anterior to the hinge line. The length from the beak is 27 mm. and from the hinge line, 21 mm.

The ventral valve is subpentagonal to ovate in outline, sharply convex in the beak area and becoming less so anteriorly. The beak is fairly sharp and well incurved. The low interarea is large, triangular, and concave. The sulcus begins at the beak, broadens anteriorly, and is bounded by two very large ribs. About one-third the distance from the beak, a few weak costae branch off the main bounding ribs into the sulcus, and increase up to 5 or 6 at the anterior margin. The flanks carry from 5 to 7 ribs decreasing in size laterally and generally bifurcating once before reaching the anterior margin.

The dorsal valve is subrectangular in outline and has a rather low convex profile. A broad rounded beak projects slightly beyond the straight hinge line. The fold consists of two coarse ribs which bifurcate once before reaching the anterior margin. There are 6 costae on each flank which gradually diminish in size laterally, the bifurcation being well marked by the larger more medial ribs.

#### Remarks.

The Tika Creek specimens although few in number, show extreme variation in outline, angularity of the sulcus, and rib pattern. Some of this variation no doubt occurs during the ontogeny of the group for, the older the shell the more elongate it becomes, the broader the sulcus, and the greater the bifurcation of the ribs.



Following the example of Stepanov (1937), and Einor (1939), the Tika Creek specimens have been interpreted loosely, using Spiriferella saranae (deVerneuil) sensu lato and Spiriferella keilhavii (von Buch) sensu lato as the extremes of what appears to be a completely intergrading series. The Tika Creek specimens have been placed in S. keilhavii sensu lato because of their more transverse outline, broader sulcus, and fairly extensive rib bifurcation.

Horizon and Locality.

Four specimens assigned to Spiriferella keilhavii senso lato were recovered from the Tika Creek section in the interval 243 to 300 feet below the top. Comparable specimens were recovered from 760 to 1460 feet below the top of the Upper Limestone Unit on Tatonduk River.

Genus Martinia McCoy, 1844

Martinia sp. A

Plate 6, figures 5-7

The description is based on U. of A. No. PR-112, showing ventral and posterior features: U. of A. No. PR-113, an internal ventral mould; and SH-8018-15, a crushed dorsal valve.

The shell is subtriangular in outline. The estimated length of U. of A. -112 is 35 mm., and the greatest width of 41 mm. occurs somewhat anterior to mid-length. The height of the ventral valve is 15 mm.

The ventral valve is subtriangular in outline and non-sulcate. The convexity is most pronounced in the umbral area and gradually tapers off towards the anterior. The beak is fairly broad and strongly incurved.



The surface of the valve is marked by a few weakly developed concentric growth lines which are most apparent near the anterior margin of the valve. The cardinal area is demarcated by a fairly sharp angle from the lateral slopes and its length along the hinge line is estimated as 22 mm. A large triangular delthyrium occupies about one-half of the cardinal area.

The dorsal valve is subcircular in outline and less convex than the ventral. A poorly developed broad fold begins near the beak and becomes more pronounced anteriorly. The ornament is similar to the ventral valve.

The anterior of the ventral valve has a rather broad depressed muscle field extending from the beak about  $1/3$  the distance anteriorly, and is divided in the middle by a low ridge. There are several grooves radiating from the beak which extend to the anterior  $1/3$  of the shell. The valve is thickest posteriorly and becomes markedly thinner anteriorly.

#### Remarks.

This species differs from Dunbar's Martinia greenlandicus in the complete absence of a sulcus and a broader muscle field in the ventral valve.

#### Horizon and Locality.

Specimens of Martinia sp. A are very abundant on the Tika Creek section in the interval 243 to 300 feet. They are represented mainly by crushed ventral valves. Martinia sp. A was recorded in the interval 1270 to 2150 feet on the Tatonduk River section.



Genus Choristites Fischer de Waldheim, 1825

Choristites soderberghi Dunbar, 1955

Plate 6, figures 8-11

Choristites soderberghi Dunbar, 1955, p.158, Plate 31, figs. 4-11

Choristites soderberghi Dunbar. Dunbar, 1961, p.229, Fig. 2, fig. 13

The description is based on SH-8018-16, showing ventral features; SH-8018-17, a crushed but complete shell; and SH-8018-18, a ventral valve sectioned to show the interior structures.

The shells are of medium size, moderately biconvex, and subtriangular in outline. They attain a length of about 41 mm. and a width of 49 mm. close to the anterior margin.

The ventral valve is subtriangular in outline, and has a convex profile, which is most pronounced in the beak area. The beak is fairly well pointed, almost erect, and overhangs the hinge line. A shallow narrow medial sulcus extends from the beak and broadens slightly to the anterior. About 11 mm. from the beak, a single costa appears in the sulcus which may bifurcate once before reaching the anterior margin. Fairly coarse, rounded costae cover the surface numbering from 8 to 9 per 10 mm. near the anterior margin. Bifurcation is minor. Concentric growth lines are also present but very irregularly developed, and are best shown on the younger parts of the valve. The cardinal area is large, slightly concave, and sharply demarcated from the lateral slopes. The delthyrium occupies approximately one-third to one-half of the area and has an apical angle of 60 to 70 degrees.

The dorsal valve is subrounded to longitudinally ovate in



outline, and has a low convex profile. The beak is broad and extends only slightly beyond the hinge line. The ornament is similar to the ventral valve but growth lines are fairly abundant giving the valve a weakly reticulate appearance.

Internally, the ventral valve has two long thin apical plates (figures 6, 7), and thick secondary deposits between the plates in the posterior region. The apical plates are easily distinguished from the secondary deposits as the calcite of the latter is not continuous across the plates, (see Chao, 1929, p.14).

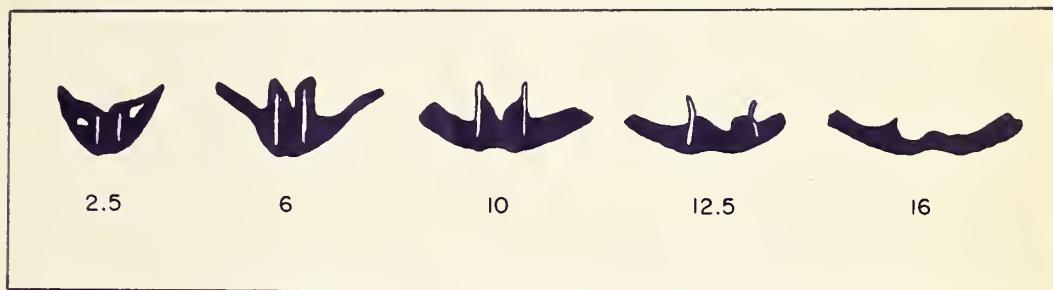


Figure 6. Series of sections through the ventral valve of SH-8018-18 showing the apical plates. Distances from the ventral beak are given in millimeters. xl

Remarks.

Externally, Choristites soderberghi closely resembles Spirifer osborni Harker. Internally however, the apical plates of Choristites soderberghi are nearly parallel while in Spirifer osborni they are markedly divergent.



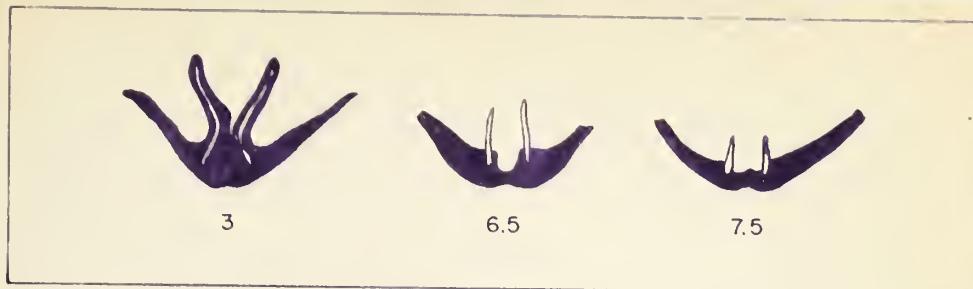


Figure 7. Series of sections through SH-8018-19. Distances from the ventral beak are given in millimeters. xl

The extent of calcite deposition between the plates is quite variable within the same species (figures 6 and 7), and is therefore probably of little significance. Figure 7 shows quite extensive secondary deposits in the posterior portion of the valve but which quickly become negligible anteriorly.

Horizon and Locality.

This species is abundant on the Tika Creek section at 300 feet below the top. It is present on the Tatonduk River section in the interval 1270 to 4070 feet.

Choristites n. sp. A

Plate 6, figures 12-16

The description is based on SH-8018-39, a fairly complete ventral valve and SH-8018-20, a sectioned ventral valve.

The width at midlength is 47 mm. while the length is approximately 38 mm. The width at the hinge is at least 44 mm. and may be greater. A large specimen, SH-8018-20, attained a length of 62 mm. and a width of 70 mm.



The ventral valve is subtriangular to subpentagonal in outline and has a very high convex profile. The beak is large, rounded and erect. A sharp sulcus begins at the beak and broadens towards the anterior. No costae arise from within the sulcus but a few enter it from the flanks until about 6 are present at the anterior margin. Coarse, rounded costae number from 4 to 7 per 10 mm. near the anterior margin and increase only slightly by bifurcation. Concentric growth lines are weakly developed and are most apparent in the younger stage of the shell. Growth lirae are very abundantly distributed over the shell surface. The cardinal area is large, triangular, slightly concave and sharply demarcated from the lateral extremities of the shell. The delthyrium occupies from one quarter to one third the cardinal area and has an apical angle of about 30 degrees.

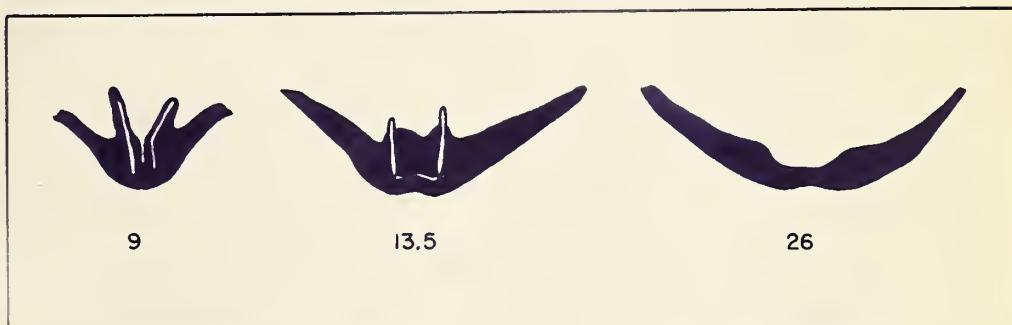


Figure 8. Series of sections through SH-8018-20. Distances from the ventral beak are given in millimeters. xl

The ventral interior has two stout strongly divergent apical plates which extend about one quarter the length of the shell. Secondary shell material unites the plates in the beak area but becomes negligible towards the anterior.



Remarks

This species differs from Choristites soderberghii in its very coarse, relatively unbifurcated costae, large cardinal area, and very high beak.

Horizon and Locality.

This species is rare 300 feet below the top of the Tika Creek section. It was not seen in the collections from the Tatonduk River section.

Genus Spirifer Sowerby, 1818

Spirifer osborni Harker, 1960

Plate 7, figures 1-3

Spirifer osborni Harker, 1960, p.65, Plate 20, figs. 15-17

The description is based on SH-8018-21, a complete specimen and SH-8018-22, a sectioned ventral valve.

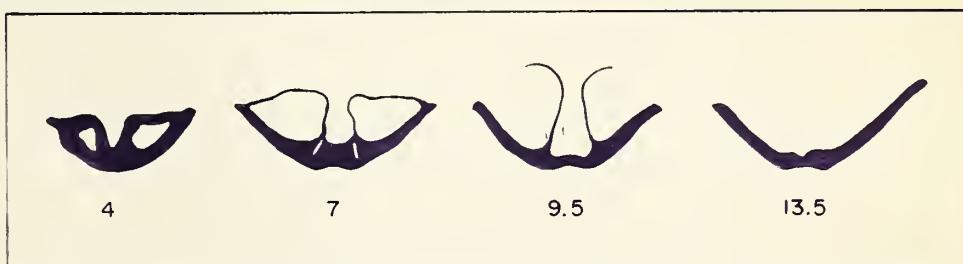


Figure 9. Series of sections through SH-8018-22. Distances from the ventral beak are given in millimeters. xl

The interior of the ventral valve has well developed, long, divergent, apical plates which extend about one-third the shell length where they terminate abruptly. A slight amount of secondary calcite may be present in the extreme posterior of the valve.



The shell is large, subpentagonal in outline, and has a subequally biconvex profile. The postulated length is 47 mm., while the width is approximately 58 mm. near the midlength of the shell.

The ventral valve is subpentagonal in outline, and has its greatest convexity in the umboinal area. The beak is erect and well pointed. Costae number 5 to 6 per 10 mm. at the anterior margin. The surface is covered with many closely spaced concentric growth lines which are most frequent posteriorly. Costal increase is not extensive and occurs by bifurcation. A sulcus begins as a narrow depression in the beak area and broadens anteriorly. Initially it contains one costa, but at the anterior margin this has increased to about 10. The slightly concave cardinal area is large, sharply demarcated from the lateral slopes of the shell, and occupies about 1/2 the maximum width of the shell. The delthyrium is relatively small occupying about 1/6 the cardinal area with an apical angle of approximately 60 degrees.

The dorsal valve is subrectangular in outline and has a convex profile. The ornament is the same as on the ventral valve.



Remarks.

As previously noted, Spirifer osborni is extremely difficult to separate from Choristites soderberghi, the critical difference is the nature of the apical plates. Sections of the Tika Creek specimen agree well with those of Harker and Thorsteinsson (1960, p.66, fig. 6), except no secondary deposition was reported in the specimens from Grinnell Peninsula. The presence of a slight amount of secondary deposition between the apical plates is considered to be a sub-specific character.

Horizon and Locality.

Spirifer osborni is rare in the Tika Creek section, occurring 300 feet below the top. It was not encountered in the collections from the Tatonduk River.

Genus Neospirifer Fredericks, 1919

Neospirifer sp. A

Plate 7, figures 4-6

The description is based on SH-8019-4, a ventral valve.

The shell is subpentagonal in outline. The maximum observed length is 25 mm., while the estimated width slightly anterior to mid-length is 32 mm. The width along the hinge line is approximately 26 mm.

The ventral valve is subpentagonal in outline with the greatest convexity in the umbonal area. The beak is rather bluntly pointed and suberect. A medial sulcus begins at the beak where it is narrow and broadens fairly rapidly towards the anterior margin. Initially the sulcus is bounded by two heavy ribs which begin to bifurcate about 4 mm. from the beak, until there are 8 costae in the sulcus at the anterior margin.



Costae on the flanks in the posterior region number about 4 and increase to 10 by mid-length, and up to 14 near the anterior margin. The bifurcations from the primary ribs tend to remain fasciculate as far as the anterior margin. The cardinal area is large and occupies about 2/3 of the hinge width. Its height is approximately 6 mm., and it is sharply demarcated from the lateral slopes of the shell. The delthyrium is fairly large and is about 1/4 the size of the cardinal area.

Remarks.

The Tika Creek species is similar to Neospirifer mexicanus latus King reported from the Leonard Formation of the Glass Mountains. The Tika Creek specimens differ however, in having a shorter and less well defined cardinal area.

Horizon and Locality.

Three incomplete specimens of this species were collected from 243 feet below the top of the Tika Creek section. It was not observed in the collections from Tatonduk River.

Genus Pterospirifer Dunbar, 1955

Pterospirifer sp. cf. P. alatus (Schlotheim), 1813

Plate 7, figures 7-11

cf. Spirifer alatus Schlotheim, 1813, p.58, Plate 2, figs. 1-3  
Spirifer cf. alatus Schlotheim. Frebold, 1937, p.49, Plate 2, fig. 2  
cf. Spirifer alatus Schlotheim. Licharew, 1939, p.211, Plate 17, figs. 2,3  
cf. Pterospirifer alatus (Schlotheim). Dunbar, 1955, p.129, Plate 22,  
figs. 19-25



Pterospirifer sp. cf. P. alatus (Schlotheim). Harker, 1960 p.68, Plate 20, figs. 1-14

The description is based on SH-8020-1, a complete ventral valve; SH-8021-1 showing ventral and dorsal features; SH-8018-23 showing fine details of the ornament; and SH-8020-2 showing internal ventral details.

The shell is short, has a long, straight hinge line, and is obtusely triangular in outline. The maximum width is along the hinge line and measures 49 mm., the length is 21 mm., and the thickness is estimated as 12 mm.

The ventral valve is broadly triangular in outline and has a gently convex profile. The cardinal extremities are flat and alate. The beak is broad, well pointed and suberect. A non-plicate sulcus begins at the beak where it is fairly shallow and broadens towards the anterior. The flanks have 13 to 14 well rounded costae which are covered with a multitude of fine interrupted radial lirae, and transverse concentric growth lirae. Both the concentric and radial lirae are present in the sulcus, but costae are lacking. The faintly striated cardinal area is very broad, sharply defined from the lateral slopes of the shell and is slightly concave. The delthyrium is large, triangular, and has an apical angle of about 60 degrees.

The dorsal valve is less convex than the ventral and is similarly ornamented. The well developed fold is non-costate, broadens rapidly towards the anterior and in some cases appears bilobed.

The interior of the ventral valve shows very thick, strongly divergent apical plates near the posterior margin which thin rapidly,



and abruptly descend to the floor of the valve about one-third the length from the beak. They continue as low narrow ridges to the anterior 1/3 of the shell and disappear.

Remarks.

The Tika Creek specimens differ from Pterospirifer alatus in lacking the medial ridge in the sulcus, having more rounded costae and having a greater length to width ratio.

Horizon and Locality.

This species is very abundant on the Tika Creek section in the interval 243 to 300 feet below the top. It was not observed in the collections from Tatonduk River.

Genus Spiriferina d'Orbigny, 1847

?Spiriferina sp. A

Plate 8, figures 1-3

The description is based on two incomplete specimens, SH-8018-24 showing dorsal, ventral and posterior features; and SH-8018-25, a partially sectioned ventral valve.

The shell is subpentagonal in outline and has an unequally biconvex profile. The length is about 21 mm., the maximum width 27 mm., and the height 18.5 mm.

The ventral valve is subpentagonal in outline, and has a steeply convex profile. A non-costate sulcus begins at the beak and broadens rapidly towards the anterior, remaining quite deep throughout its length. Each flank has about 13 low, well rounded costae which are



covered with a multitude of microscopic, radially directed grooves being on the average 1/2 to 3/4 mm. in length. A few irregularly placed concentric growth lirae traverse the ribs. This radial and concentric micro-ornament is also present in the sulcus. The shell is somewhat exfoliated on the cardinal area showing the presence of very fine punctae. The cardinal extremities are acute. The beak is very high, pointed, and erect. A rather narrow delthyrium is present having arched sides and an apical angle of about 30 degrees. The cardinal area is horizontally and vertically striated and is only weakly differentiated from the lateral slopes of the shell.

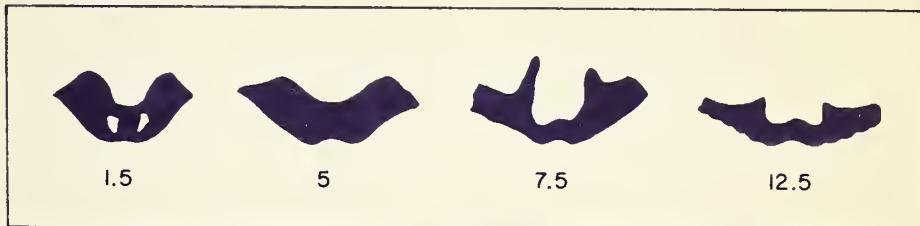


Figure 10. Series of sections through SH-8018-25. Distances from the ventral beak are given in millimeters. xl

The dorsal valve is subtrapezoidal in outline and has a very convex profile. The micro-ornament is identical to that of the ventral valve and is well developed on the fold.

Internally, the ventral valve is thickened in the beak area, but quickly becomes thinner anteriorly between the apical plates. The apical plates do not extend beyond the posterior one third of the valve, and terminate abruptly. A slight swelling in the center of the valve may make a degenerate medial septum.

#### Remarks.

This species is questionably assigned to the genus Spiriferina



since it has all the prescribed features of the genus except the medial septum. Only one specimen was available for sectioning and here the septum could have been destroyed.

Horizon and Locality.

Two incomplete specimens of this species were recovered from the Upper Mattson Formation, 300 feet below the top of the measured section. It was not encountered in the Tatonduk River collections.

Superfamily Orthotetacea Williams, 1953

Family Schuchertellidae Stehli, 1954

Genus Streptorhynchus King, 1850

Streptorhynchus kempei Andersson, 1914

Plate 8, figure 4

Streptorhynchus kempei Andersson. Dunbar, 1955, p.63, Plate 1, figs. 1-13; Plate 32, figs. 9, 10

Streptorhynchus kempei Andersson. Harker, 1960, p.50, Plate 15, figs. 1-6

The description is based on a single specimen, SH-8018-26, an internal ventral valve.

The ventral valve is subpentagonal in outline, and has a length of 32 mm. The maximum width is 35 mm. in the anterior one-third of the valve. It has a very low convex profile and the anterior margin is well rounded with the curvature continuing around the lateral margins until reaching a small flat ear near the posterior cardinal extremities. The external surface is ornamented with many fine radial costae numbering 20 per 10 mm. at the anterior margin. There are also some irregular, weak



concentric growth lines. The cardinal area is triangular, horizontally striated and steeply inclined toward the hinge line. The delthyrium, covered by a convex pseudodeltidium, occupies approximately 1/4 of the area and has an apical angle of about 40 degrees.

Internally the diductor scars are very prominent, fairly large, and slightly depressed. The ovate adductor scars are much smaller. The teeth are stout and supported by ridges running along each side of the delthyrium. Dental lamellae are lacking.

Remarks.

Although the Tika Creek specimen is somewhat smaller, it is identical to those reported from Grinnell Peninsula.

Horizon and Locality.

One specimen was collected from 300 feet below the top of the Tika Creek section. It was not seen in the collections from Tatonduk River.

Streptorhynchus sp. cf. S. stoschensis Dunbar, 1955

Plate 8, figures 5-6

cf. Streptorhynchus stoschensis Dunbar, 1955, p.65, Plate 2, figs. 1-15; Plate 32, figs. 6-8

The description is based on two poorly preserved juvenile specimens: SH-8018-27, an exfoliated ventral valve; and SH-8018-28, a ventral interior.

The length of SH-8018-27 is 22 mm., and the maximum width slightly anterior to mid-length is 22 mm. The shell is subtriangular



in outline and is slightly convex. The anterior margin is well rounded and curves into the rather straight lateral margins which converge to the high pointed beak. The surface is covered with fine curved costae which number about 20 per 10 mm. at the anterior margin. The costae bifurcate once near midlength, and again near the anterior margin.

Remarks.

The fragmentary specimens do not allow a more positive specific assignment but appear to be quite comparable to Dunbar's specimens.

Horizon and Locality.

This species occurred at 243 feet below the top of the Tika Creek section. It was not observed in the Tatonduk River collections.

Superfamily Stenoscismatacea Shrock and Twenhofel, 1953

Family Stenoscismatidae Muir-Wood, 1955

Genus Stenoscisma Conrad, 1839

Stenoscisma n. sp. A

Plate 8, figures 7-10

The description is based on SH-8018-29 showing ventral features; SH-8018-31, a complete sectioned specimen; and SH-8018-32, a crushed dorsal valve.

The shell is subtriangular in outline and unequally biconvex in profile. The length of SH-8018-29 is 36 mm., while its maximum width about midlength is 40 mm. SH-8018-30, a juvenile has a length of 26 mm. and a width of 29 mm.



The ventral valve is subtriangular in outline and has a rather low convex profile with the maximum convexity in the unbonal region. The beak is erect, broad, and bluntly pointed. A very broad sulcus begins about midlength where it occupies approximately half the shell width and broadens slightly to the anterior. It is not readily discernible until the anterior 1/3 of the shell, and creates a well defined sulcate anterior commissure. The surface ornament consists of very abundant fine concentric growth lirae which become incised to some degree on the posterolateral slopes. There are no plications on the valve. The cardinal extremities steepen abruptly just above the hinge line. The cardinal area is small, mostly occupied by the broad-based triangular delthyrium and in the complete shell is completely hidden by the overhanging beak.

The dorsal valve is subrounded in outline and somewhat more convex than the ventral valve. The ornamentation is similar to the ventral valve, in its complete lack of plications.

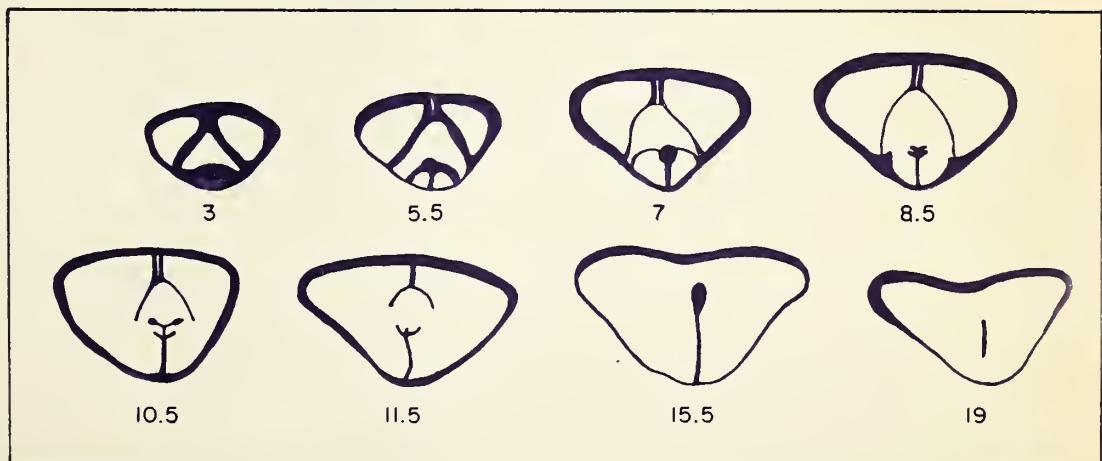


Figure 11. Series of sections through SH-8018-31. Distances from the ventral beak are given in millimeters. xl

Internally, the ventral valve has two stout, divergent dental plates forming a spondylium and touching the floor of the valve at the beak.



Anteriorly, the spondylium becomes a spondylium duplex. The ends of the dental plates lose their contact with the shell quickly and become thinner until they disappear at about midlength (figure 11).

The interior of the dorsal valve has well developed crural plates supported by a medial septum. A bilobed, stalked, cardinal process arises from between the crural plates. The cardinal process persists only a short distance, and leaves a septalium with an additional small stalk between the plates. About half the length of the valve, the septalium is covered and extended on the septum far into the ventral interior, after which it is quickly lost.

Remarks.

The Tika Creek species differs from the more typical Stenoscisma in its complete lack of radial ornament. It has the internal structure typical of the group however.

Stenoscisma n. sp. is most closely related to S. sella (Kutorga) but differs in being less convex, possessing a deeper sulcus and having a more rounded outline. The internal structure of S. sella is not known.

Horizon and Locality.

This species is fairly abundant 300 feet below the top of the upper portion of the Mattson Formation on Tika Creek, where most specimens were incomplete ventral valves. Stenoscisma n. sp. was not encountered in the Tatonduk River collections.



Class Inarticulata

Superfamily Discinacea

Family Discinidae

Genus Orbiculoides d'Orbigny, 1847

Orbiculoides sp. A

Plate 8, figure 11

The description is based on two partial specimens, SH-8018-33 and SH-8018-34.

The shells are circular in outline and discoidal. The diameters of the two specimens are 20 and 24 mm. The ventral valve appears to be slightly convex medially corresponding to a weakly developed concavity on the dorsal valve. Both valves are covered with about 20 fine, depressed concentric lines, and separated by wide flattened areas.

The pedicle slit is off-center slightly, radially directed, and measures approximately 2.5 mm. in length.

Horizon and Locality.

These specimens occurred 300 feet below the top of the Tika Creek section. This species was not observed in the collections from Tatonduk River.

Phylum Mollusca

Class Gastropoda

Subclass Prosobranchia

Order Archaeogastropoda

Suborder Macluritina

Superfamily Euomphalacea

Family Euomphalidae



Genus Cyclicioscapha Yochelson, 1956

Cyclicioscapha sp. A

Plate 8, figures 12-13

The description is based on SH-8018-35, a complete shell.

The shell is discoidal and dextrally coiled. The umbilicus is deep and the whorls are subrectangular in section. The exhalant channel is represented as a weakly to strongly noded angulation on the outer edge of the whorls. A supplementary angulation appears just below the nodular primary one. The surfaces of the whorls are radially striated.

The dimensions of the shell are: maximum diameter, 19 mm.; thickness of last whorl at the aperture, 8 mm.

Horizon and Locality.

This species is very abundant at 300 feet below the top of the Tika Creek section, and was not encountered in the collections from Tatonduk River.





EXPLANATION OF PLATE 1

(all figures are X80 unless indicated otherwise)

Smaller foraminifera from  
the Tika Creek section

- Figures 1, 2: Ammodiscus sp. A; 1-side view, 2-peripheral view, U. of A. No. PR-115..... p. 25
- Figures 3, 4: Haplophragmoides sp. A; 3-side view, 4-apertural view, U. of A. No. PR-116, (X170)..... p. 26
- Figure 5: Ammobaculites sp. A; side view, U. of A. No. PR-117, (X160)..... p. 27
- Figures 6, 7: Spiroplectammina sp. A; 6-side view, 7-front view, U. of A. No. PR-118..... p. 28
- Figures 8, 9: Nodosinella sp. A; 8-side view, 9-apertural view, U. of A. No. PR-119..... p. 30
- Figures 10,11: ?Palaeotextularia sp. A; 10-side view, 11-apertural view, U. of A. No. PR-120..... p. 31
- Figures 12,13: ?Palaeotextularia sp. B; 12-front view, 13-side view, U. of A. No. PR-121. (X60)..... p. 32

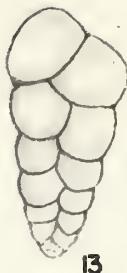
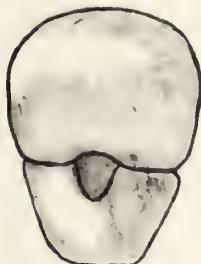
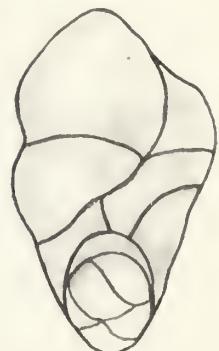
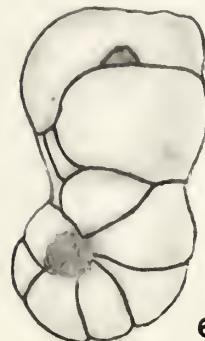
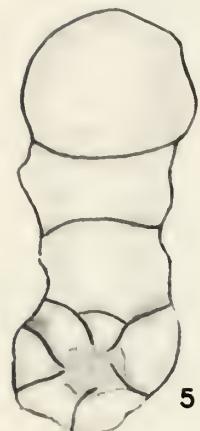
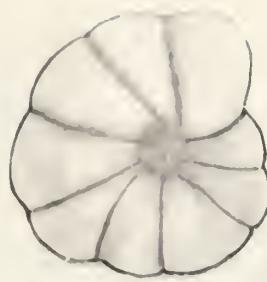


PLATE I





EXPLANATION OF PLATE 2

Fusulinid from the  
Tatonduk River Section

(all figures are X10)

- Figures 1-7: Schwagerina hyperborea (Salter); 1,2-tangential sections, U. of A. No. PR-156 and U. of A. No. PR-157; 3-axial section, U. of A. No. PR-144; 4-axial section, U. of A. No. PR-145; 5-sagittal section, U. of A. No. PR-146; 6-axial section, U. of A. No. PR-147; sagittal section, U. of A. No. PR-148..... p. 33-35

Ostracods from the  
Tika Creek section

(all figures are X25 unless indicated otherwise)

- Figures 8, 9: Glyptopleuroides sp. A; 8-left valve, 9-right valve, U. of A. No. PR-122 and PR-123 respectively..... p. 36

- Figures 10-13: Pseudoparaparchites sp. A; 10-right valve, U. of A. No. PR-124; 11-right valve, 12-left valve, 13-dorsal view, U. of A. No. PR-125..... p. 37

- Figures 14-16: Bairdia sp. cf. B. hurwitzi Coryell and Booth; 14-left valve, 15-right valve, 16-dorsal view, U. of A. No. PR-127..... p. 40

- Figures 17, 18: Bairdia sp. cf. B. matfieldensis Upson; 17-right valve, 18-dorsal view, U. of A. No. PR-126..... p. 39

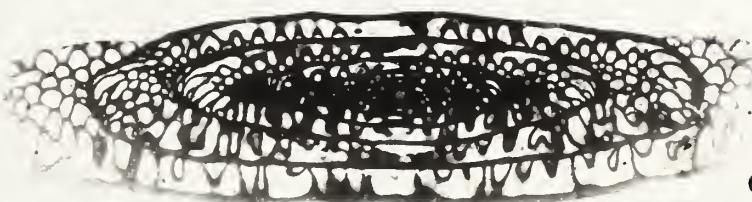
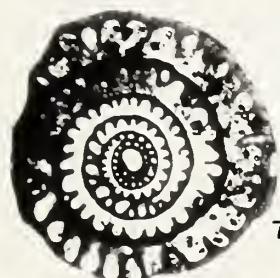
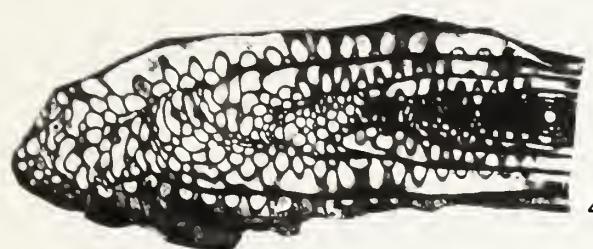
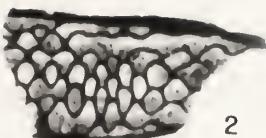


PLATE 2





EXPLANATION OF PLATE 3

Ostracods from the

Tika Creek section

(all figures are X25 unless indicated otherwise)

- Figures 1-4: Healdia subangularis Delo; 1-left valve,  
2-dorsal view, 3-right valve, U. of A. No.  
PR-128; 4-left valve, U. of A. No. PR-129..... p. 42
- Figures 5-8: Healdia sp. A; 5-dorsal view; 6-left valve,  
7-right valve, U. of A. No. PR-130; 8-right  
valve, U. of A. No. PR-131..... p. 43
- Figures 9-11: Waylandella sp. A; 9-left valve, 10-dorsal  
view, 11-right valve, U. of A. No. PR-132..... p. 45
- Figures 12-14: Waylandella sp. B; 12-left valve, 13-right  
valve, 14-dorsal view, U. of A. No. PR-133..... p. 46
- Figures 15-17: Healdioides sp. A; 15-right valve, 16-dorsal  
view, 17-left valve, U. of A. No. PR-134..... p. 47
- Figures 18-21: Seminolites sp. A; 18-dorsal view, 19-right  
valve (X80), 20-left valve, 21-right valve,  
U. of A. No. PR-135..... p. 49
- Figures 22-24: Pseudobythocypris pediformis (Knight); 22-right valve,  
23-dorsal view, 24-left valve, U. of A. No.  
PR-158..... p. 50



PLATE 3



Explanation of Plate 3 (continued)

- Figures 25-29: Cavellina ellipticalis Hamilton; 25-dorsal view, 26-right valve, 28-left valve, U. of A. No. PR-136; 27-left valve, 29-right valve, U. of A. No. PR-137..... p. 52
- Figures 30-34: Cavellina sp. cf. C. fittsi Kellett; 30-right valve, 31-left valve, U. of A. No. PR-138; 32-left valve, 33-dorsal view, 34-right valve, U. of A. No. PR-139..... p. 53
- Figures 35-38: Graphiadactylis sp. A; 35 dorsal view, 36-right valve, 37-left valve, U. of A. No. PR-140; 38-left valve showing ornament of PR-141 (X80)..... p. 54





EXPLANATION OF PLATE 4

Brachiopods from the

Tika Creek and

Tatonduk River sections

(all figures are XI unless indicated otherwise)

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\*Specimen from south of Tatonduk River section.

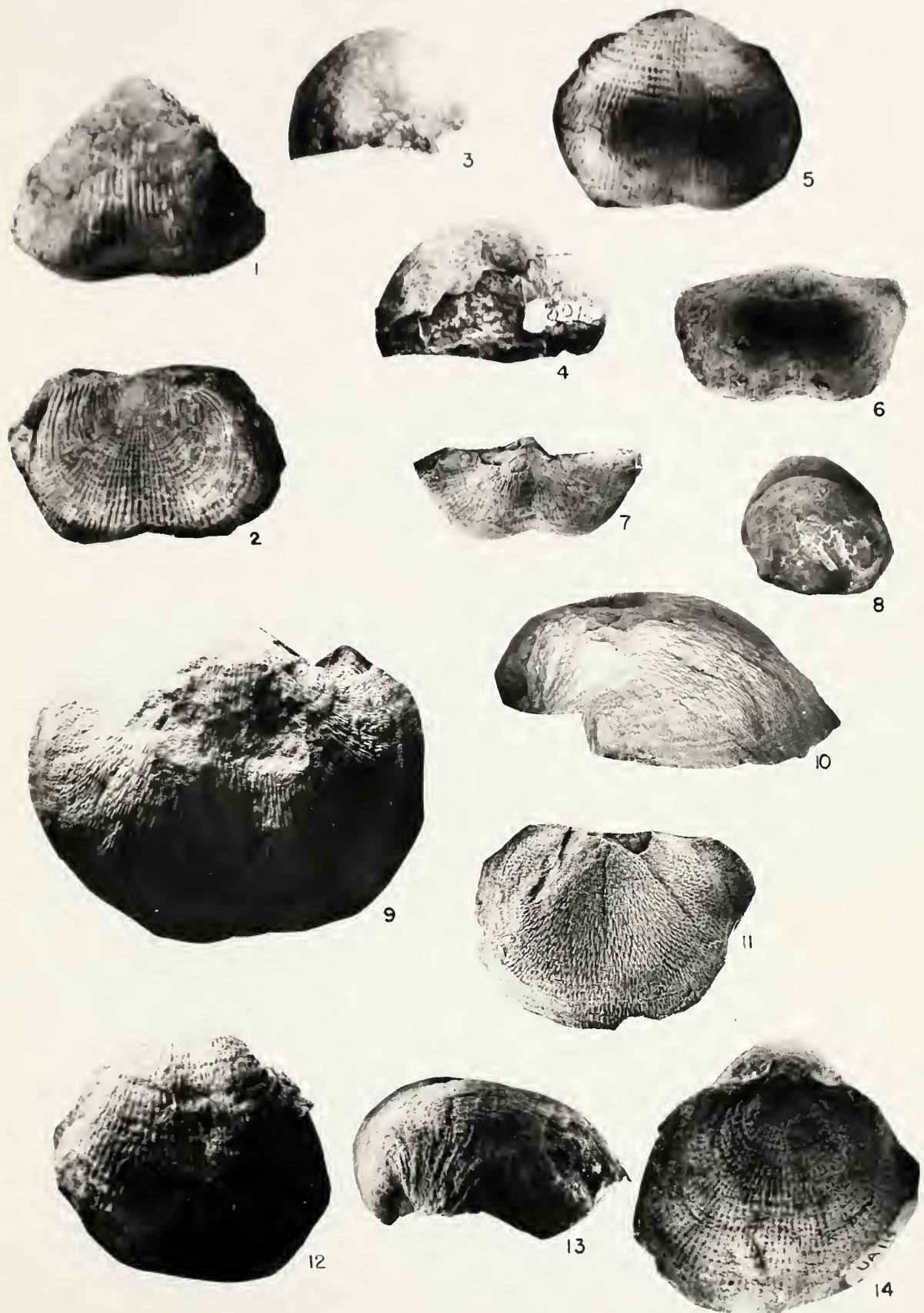


PLATE 4





EXPLANATION OF PLATE 5

Brachiopods from the

Tika Creek and

Tatonduk River sections

(all figures are XI unless indicated otherwise)

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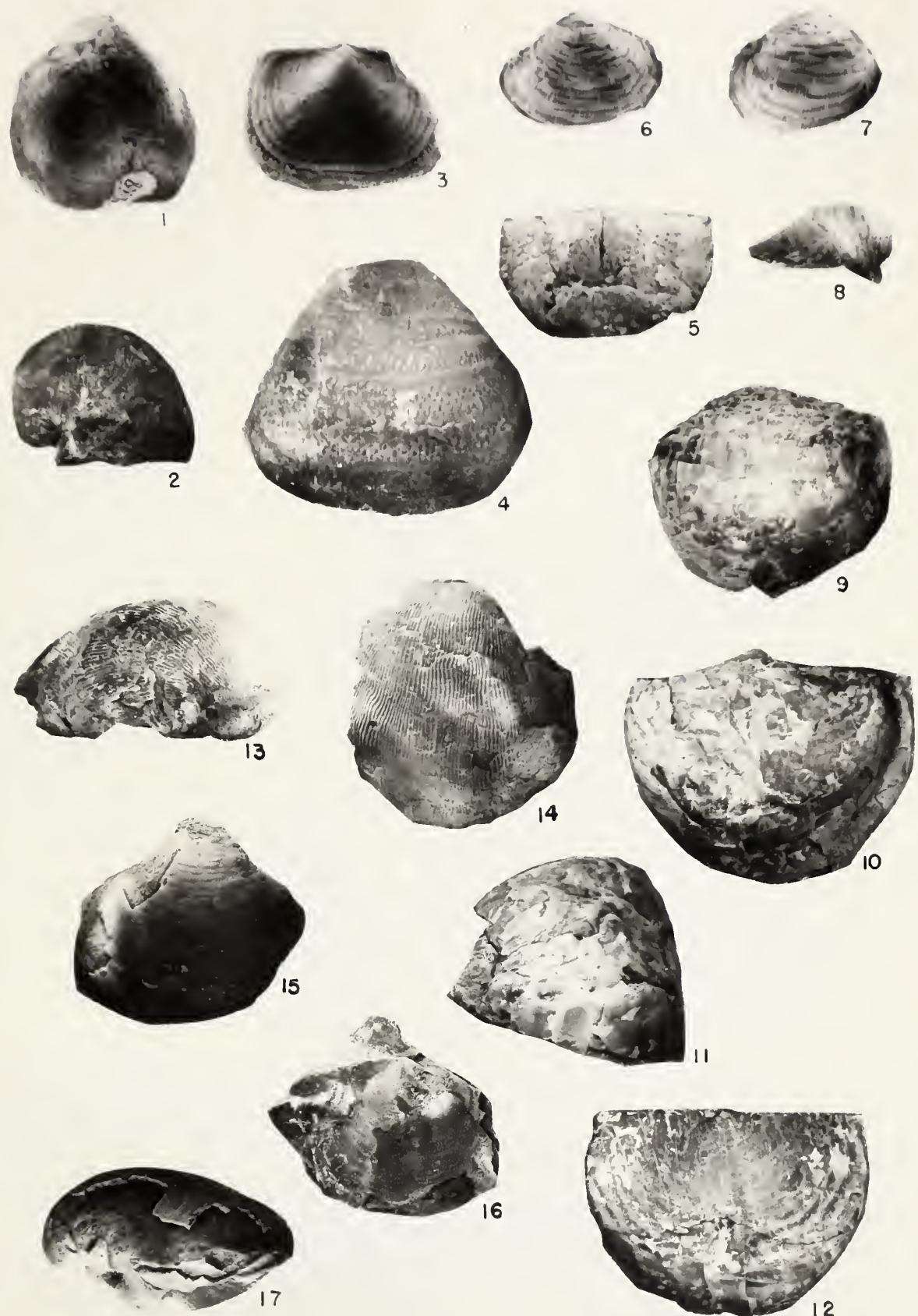


PLATE 5





EXPLANATION OF PLATE 6

Brachiopods from the

Tika Creek Section

(all figures are XI unless indicated otherwise)

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PLATE 6





EXPLANATION OF PLATE 7

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Tika Creek section

(all figures are XI unless indicated otherwise)

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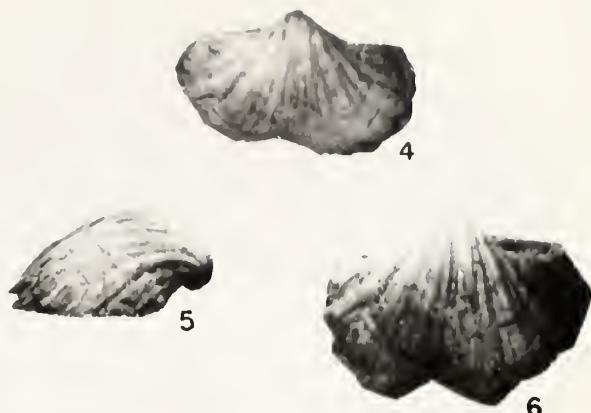


PLATE 7





EXPLANATION OF PLATE 8

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Tika Creek section

(all figures are XI unless indicated otherwise)

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